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Audit in Practice: Surveillance for hypoglycaemia in the Neonatal Paediatric Intensive Care Unit

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ABSTRACT: Hypoglycaemia in neonates is defined as a blood glucose ≤ 2.6 mmol/l. Certain categories of babies are at particularly high risk of developing hypoglycaemia in the first few days of life, and are routinely monitored in the Neonatal Paediatric Intensive Care Unit by reagent strips using a reflectance meter. This study shows that the current glucose meter, in use in the entire Department of Health, is unreliable in the detection of hypoglycaemia in neonates, but is accurate for values of blood glucose >3 mmol/l. For this reason, laboratory blood glucose estimation should be used for screening of neonatal hypoglycaemia until such time that a more reliable technique for bedside assay of blood glucose becomes available in the Neonatal Paediatric Intensive Care Unit.

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Introduction

Glucose is an essential metabolite that is used throughout the body as an energy source. After delivery, the normal baby must adapt from a continuous transplacental supply of glucose, to an intermittent enteral source of milk. The usual sequence of events at birth is a fall in blood glucose, followed by a rise in circulating glucagon and adrenaline, mobilisation of fat from peripheral stores, and production of glucose from the breakdown of hepatic glycogen[1].

Hypoglycaemia in the neonatal age group is defined as a blood glucose level 2.6 mmol/l [2]. Risk factors for the development of hypoglycaemia include prematurity, infants born small for gestational age (defined as weight 10th centile), infants of diabetic mothers, birth asphyxia, starvation, sepsis, cold injury, congenital heart disease, rhesus incompatibility, and maternal treatment including glucose infusions and drugs (e.g. -agonists used to delay labour in premature infants)[3].

Hypoglycaemia and its deleterious effects in the full term and premature neonate have been recognised since 1911[4]. The brain consumes glucose at a high rate compared to other organs. The neonatal brain comprises 12% of the body's total mass, when compared to 2% for an adult. Hence, the typical rate of glucose production in a neonate of 4-6 mg/kg/minute is far higher than in an adult[5]. Short-term effects include central nervous system dysfunction which has been demonstrated by impaired auditory brain stem and somatosensory evoked potentials in infants at blood glucose levels ≤ 2.6 mmol/l [6]. Prolonged and/or severe hypoglycaemia may result in long-term morbidity including mental retardation, delayed development and cerebral palsy[7,8].

Hypoglycaemia in neonates may be symptomatic or asymptomatic[9], therefore monitoring of blood glucose levels is essential for the detection and treatment of asymptomatic hypoglycaemia in high-risk neonates.

Traditionally, glucose monitoring in high risk neonates in Malta was carried out with reagent strips using a reflectance meter, generically known locally as dextrostix or DXT. This provides a quick and cheap screening test when compared to laboratory estimation of blood glucose. In accordance with unit policy, in the event of a DXT ≤ 2.6 mmol/l, low blood glucose levels are confirmed by a laboratory sample and appropriate treatment instituted. Treatment varies according to the severity and duration of hypoglycaemia, and escalates from a simple milk feed, to a bolus dose of glucagon, to a bolus of dextrose solution followed by an intravenous infusion, which may need to have a high concentration of glucose and may therefore require central access[4].

It is recognised that monitoring of blood glucose by various reagent strip methods is inaccurate at lower levels of glucose, and inaccuracy is compounded by a high haematocrit, and varying ambient temperatures at which meters are operated[10].

The aim of this study was to assess the new bedside monitoring system (Medisense) that was recently introduced for the entire Health Division in Malta versus laboratory estimation of blood glucose in patients admitted to Neonatal Paediatric Intensive Care Unit (NPICU).

Methods

Laboratory estimation of blood glucose (Hitachi 912: glucose oxidase GOD-PAP) was taken as the control. Hypoglycemia was defined as blood glucose 2.6 mmol/l. It is the policy for all newly admitted patients to the NPICU to undergo routine reagent strip glucose estimation. Infants at high risk are also monitored for the first few day/s of life. For the duration of the study period (20/06/98-05/08/98), blood was taken for simultaneous bedside and laboratory glucose estimation. Care was taken to obtain a full drop of blood onto reagent strips as recommended by the strip manufacturer while free flowing blood (arterial or venous) was being taken for laboratory glucose estimation.

Sensitivity, specificity, positive predictive values and

Table 1: Sensitivity, specificity, positive predictive values and negative predictive values for Medisense (20/06/98-05/08/98

		Hypoglycemia	
		Present	Absent
DXT	Positive	10	9
	Negative	6	34

Results	
Sensitivity	62.5%
Specificity	79.1%
Positive predictive value	52.6%
Negative predictive value	85.0%

negative predictive values were calculated[11]. In this setting, sensitivity of DXT was defined as how many hypoglycemic patients were simultaneously found to have a low DXT. Specificity of DXT was defined as how many of those without hypoglycaemia had a DXT within the normal range. Positive predictive value was defined as how many of those with a DXT showing hypoglycaemia were really hypoglycaemic. Negative predictive value was defined as how many of those with a normal DXT were really not hypoglycaemic. Linear regression analysis was performed and Kendall's τ was used for correlations. A p value ≤ 0.05 was taken to represent a statistically significant result.

Table 2: Results of correlation and linear regression analysis between RBG and DXT (Medisense)

	Correlation analysis			Linear regression analysis			
For values of RBG	n	Kendall's τ	p	Intercept	r	t statistic	p
≤ 3 mmol/l	23	0.04	0.79	2.12	0.08	0.22	0.83
> 3 mmol/l	36	0.56	<0.0001	-0.08	1.04	20.60	<0.0001

Results

Sensitivity, specificity, positive predictive values and negative predictive values for the detection of hypoglycaemia using Medisense are shown in Table 1. Poor values were obtained for all four measures.

Results of correlation and linear regression analysis are shown in Table 2. There is a close agreement between RBG and DXT for values of RBG >3 mmol/l, but a poor correlation for values of RBG ≤ 3 mmol/l.

Discussion

The new meter (Medisense) is clearly unsatisfactory for the detection of hypoglycaemia in neonates, and hypoglycaemia may be missed, or treatment for hypoglycaemia may be inappropriately instituted.

The lack of sensitivity, specificity, poor/low, positive and negative predictive values for glucose meters is attributed to the fact that conventional DXT machines are designed to detect hyperglycaemia in older patients. The glucose monitoring policy in NPICU has changed as a result of this study, such that DXTs are not performed and assessment of blood glucose is carried out on a formal laboratory blood sample.

If the policy of using bedside estimation of blood glucose in NPICU is to be re-instituted, consideration should be given to the purchase of a meter which is sensitive and specific in the low range of blood glucose[12]. It is likely that such a meter will only be required for NPICU use, and that it would be cost-effective since the number of samples of blood sent for formal laboratory assay would drastically diminish.

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COMMENTARY

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Drs. Grech and Soler, in their article on routine surveillance of hypoglycaemia in newborns, have raised a number of important issues. Firstly, they have confirmed the problems with the use of stick tests based on reflectence monitoring in this cohort of patients. Secondly, they have highlighted the importance of in-house auditing of medical procedures and, by doing so, have confirmed the inaccuracy of a (previously) standard mode of glucose measurement, with potential dire consequences to the patient. Finally, as a result of this audit, appropriate measures have been taken to correct the problem. Indeed, the use of glucose-stix monitors was discontinued on the NPICU and a formal request for a non-stick based monitor suitable for the neonatal age group made. One such glucose monitor which uses a micro-cuvette for blood sampling has now been procured and is in use on the NPICU. Preliminary paired sampling with whole blood laboratory measurements have shown a close correlation. This will eliminate further problems with unreliable glucose results, improve the standard and safety of neonatal care, and provide a cost benefit by considerably restricting the need for laboratory glucose measurements.

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