Journal of Paediatrics and Child Health

doi:10.1111/jpc.12293

ORIGINAL ARTICLE

Audit of a clinical guideline for neonatal hypoglycaemia screening

Samantha L Sundercombe,[1] Camille H Raynes-Greenow,[2] Angela E Carberry,[2,3] Robin M Turner[2] and Heather E Jeffery[1,2,3]

[1]Sydney Medical School, [2]Sydney School of Public Health, University of Sydney and [3]Department of Neonatal Medicine, Royal Prince Alfred Hospital, Sydney, Australia

Aim: This study aims to evaluate adherence to a clinical guideline for screening and prevention of neonatal hypoglycaemia on the post-natal wards.

Methods: Retrospective chart review of 581 healthy term neonates born at a tertiary maternity hospital. Indications for hypoglycaemia screening included small for gestational age (SGA), infants of diabetic mothers (IDM; gestational, Type 1 or 2), symptomatic hypoglycaemia, macrosomia and wasted (undernourished) appearance. Outcomes were protocol entry and adherence with hypoglycaemia prevention strategies including early and frequent feeding and timely blood glucose measurement.

Results: Of 115 neonates screened for hypoglycaemia, 67 were IDM, 19 were SGA (including two both IDM and SGA), and two were macrosomic. One IDM and one SGA were not screened. Twenty-two neonates were screened for a reason not identifiable from the medical record, and 13 neonates were SGA by a definition different to the guideline definition, including five who were also IDM. Guideline adherence was variable. Few neonates (41 of 106, 39%) were fed in the first post-natal hour, and blood glucose measurement occurred later than recommended for 41 of 106 (39%) of neonates.

Conclusions: Most IDM and SGA neonates were screened. While guideline adherence overall was comparable with other studies, neonates were fed late. We recommend staff education about benefits of early (within the first hour) frequent breastfeeding for neonates at risk.

Key words: clinical audit; clinical guideline; guideline adherence; hypoglycaemia; infant (newborn).

What is already known on this topic

1 Neonatal hypoglycaemia though rare can have severe outcomes including death and neurological deficits.
2 Most hospitals in Australia have clinical guidelines to screen for and prevent the condition.
3 The effectiveness of clinical practice guidelines requires assessment.

What this paper adds

1 This is the first published study of adherence to neonatal hypoglycaemia guidelines in Australia.
2 Timely initiation of breastfeeding within the first hour after birth and initiation of blood glucose measurement were suboptimal and are important indicators for re-evaluation.
3 Identification of small for gestational age and infants of diabetic mothers at risk of hypoglycaemia was very good.*

Neonatal hypoglycaemia is associated with poor neurodevelopmental outcomes, brain damage and death.[1–3] Most Australian hospitals with a neonatal unit report using clinical guidelines to identify and treat neonatal hypoglycaemia.[4] Evidence about the consequences of neonatal hypoglycaemia, optimal management and impact of treatment on outcomes is limited,[5–7] therefore neonatal hypoglycaemia guidelines are based largely on expert opinion and 'operational thresholds'.[8]

The effectiveness of any clinical practice guidelines requires assessment. Assessment for hypoglycaemia should include whether the guidelines are adhered to and increase detection and reduce severity of hypoglycaemic episodes in those screened. However, there is little published research on adherence to such guidelines.[9–11]

The aim of this study was to examine in a sub-population of healthy term neonates adherence to a clinical guideline for neonatal hypoglycaemia screening in a large, tertiary maternity hospital in Sydney, Australia. The specific objectives were twofold: (i) to determine the proportion of neonates considered at risk of hypoglycaemia that were screened for hypoglycaemia; and (ii) to determine adherence to the clinical practice guideline.

Correspondence: Professor Heather E Jeffery, International Maternal and Child Health, Sydney School of Public Health, Edward Ford Building (A27), The University of Sydney, NSW 2006 and Royal Prince Alfred Hospital, Newborn Care, Missenden Road Sydney, Australia. Fax: +61 2 9550 4375; email: heather.jeffery@sydney.edu.au

Conflicts of interest: The authors have no personal or financial relationships to disclose relevant to this article.

Accepted for publication 9 April 2013.

*[Correction added on 1 July 2013, after first online publication: "Identification of smell for gestational age and influence of diabetic mothers at risk of hypoglycaemia was very good" was changed to "Identification of small for gestational age and infants of diabetic mothers at risk of hypoglycaemia was very good".]

Materials and Methods

Guideline entry – screening

The study population included term healthy neonates born and managed on the post-natal ward at Royal Prince Alfred Hospital (RPAH), Sydney, Australia, between September and October 2010. The number of these neonates who had blood glucose screening was determined by chart review to estimate the proportion of neonates who received hypoglycaemia screening out of those who had an indication for screening. According to the protocol, indications for hypoglycaemia screening included (i) an infant of a diabetic mother (IDM; gestational, Type 1 or Type 2), with gestational diabetes mellitus diagnosed according to the Australasian Diabetes in Pregnancy Society criteria[12] and determined by maternal and laboratory record review; (ii) small for gestational age (SGA), defined as birthweight <2500 g for 37–38 months, <2600 g for 39 months and <2800 g for 40+ weeks gestation; (iii) symptomatic hypoglycaemia defined by signs including poor feeding and jitteriness; (iv) wasted appearance; and (v) macrosomic appearance, with increased subcutaneous fat, plethora and a relatively small head (Appendix S1).

Guideline adherence

A checklist of seven criteria was developed from the guideline (Appendix S1), and the proportion of neonates whose management complied with each criterion was determined by reviewing the feeding charts of those neonates screened for hypoglycaemia who remained on the post-natal ward. A 'feed' was defined as a code 5 or 6 out of 6 breastfeed indicating good nutritive sucking or EBM or formula as recorded on the chart reasoning that only nutritive feeds alter blood glucose. Adherence to the following criteria was calculated: (i) first feed within first hour after birth; (ii) fed at least five times in the first 24 h; (iii) second feed in the first 6 h; (iv) blood glucose measured after the second feed; (v) glucose measured within 7 h of birth; (vi) at least three blood glucose levels measured; and (vii) had glucose monitoring for at least 12 h after birth. We were also able to measure time discrepancies to the time dependent criteria. We examined the relationship between mode of delivery and adherence.

Hypoglycaemia incidence (according to positive screening test)

All blood glucose measurements on the feeding charts were recorded to document the incidence of hypoglycaemia, which was defined as blood glucose level ≤2.0 mM in the first 24 h and ≤2.5 mM afterwards for full-term asymptomatic neonates. Capillary blood was obtained by heel prick and glucose levels measured using the Accu-Check Advantage (Roche Diagnostics, Castle Hill, Australia) glucometre and test strips. These glucometres were subject to monthly quality assurance review.

Statistical analysis

We used *t*-tests to compare continuous demographic variables. Associations between discrete variables were investigated using the Fisher's exact χ^2 test and the rate ratio (RR) estimated. *P*-values less than 0.05 were considered statistically significant. The 95% confidence intervals were estimated for the percentage adherence to each guideline criterion. All analyses were conducted in Stata 11.2 (Stata Corporation, College Station, TX, USA).

The study was approved by the Human Research Ethics Committees of RPAH (HREC/09/RPAH645, SSA/09/RPAH646) and the University of Sydney (Ref. no. 12732).[13] Informed parental written consent was obtained, and participation was voluntary.

Results

Guideline entry

Of the 581 full-term neonates, 115 (20%) had at least one glucose level measured. Neonates on the guideline were younger, smaller, more commonly born to primiparous women, more likely to have an Asian mother and less likely to have had a normal vaginal delivery (NVD) (Table 1). Most neonates at risk of hypoglycaemia according to the guideline were screened, with only one of 68 IDM and one of 19 SGA neonates missed (Table 2); two neonates were both IDM and SGA. The missed SGA infant weighed only 5 g less than the 2800 g cut-off. There were no cases of clinically detected hypoglycaemia.

Of the neonates on the hypoglycaemia guideline, 13 (including five that were also IDM) were SGA defined by <10th percentile weight for gestational age but not SGA according to the guideline definition, two were macrosomic and we could not determine the entry criteria for the remaining 22 (19%). The total number of neonates who were identified as wasted or macrosomic by clinicians was not known as this was not recorded.

Guideline adherence

Nine neonates screened for hypoglycaemia were excluded from the guideline audit as they were subsequently admitted to the neonatal intensive care unit where different guideline actions are required. None of these were admitted for hypoglycaemia. Feeding charts of 106 neonates were reviewed. All seven adherence criteria were followed for 35 neonates (33%), six of seven criteria for 25 neonates (24%), five criteria for 23 neonates (22%), four criteria for 15 neonates (14%), three criteria for six neonates (6%) and two criteria for two neonates (2%). No neonates had one or fewer of the seven criteria followed. Over the seven criteria (Fig. 1), the median percentage adherence was 73%. A sensitivity analysis excluding neonates with an unknown indication for screening (n = 80 IDM and/or SGA neonates) showed similar results (data not shown).

The most common adherence problem was feeding in the first hour; of the 106 babies, only 41 (39%, 95% confidence interval (CI) 29, 49), received a nutritive feed in the first hour after birth of the 80 babies with a known indication for screening this number was 34 (43%, 95% CI 33, 53) (Fig. 1). The median time between birth and the first nutritive feed was 1 h and 26 min for the 106 (Fig. 2) and 1 h and 15 min for the 80 neonates. As good nutritive sucking in the perinatal period is not always

Table 1 Characteristics of study population and comparison of total population to those screened for hypoglycaemia

	Total study population ($n = 581$)		Neonates screened for hypoglycaemia ($n = 115$)		
	Mean	SD	Mean	SD	*P*
Gestational age (week)	39.5	1.12	39.2	1.18	<0.001*
Birthweight (g)	3435	465	3186	609	<0.001*
Mother's mean age	31.5	5.37	31.8	4.72	0.541
5 min Apgar score	8.97	0.597	8.88	0.651	0.0544
	n	(%)	n	%	*P*
Sex (male)	301	(52)	58	(51)	0.073
Parity (primipara)	328	(56.5)	79	(68.7)	0.003*
Maternal country of birth					0.001*
Australian, New Zealander or other Pacific	277	(47.7)	42	(36.5)	
Asian	193	(33.2)	57	(49.6)	
European	77	(13.3)	10	(8.70)	
Other	30	(5.16)	6	(5.22)	
Unknown	4	(0.69)	0	(0)	
Highest level of education					0.214
Tertiary	400	(68.9)	86	(74.8)	
Secondary or less	165	(28.4)	28	(24.4)	
Unknown	16	(2.75)	1	(0.87)	
Hypertension					0.298
Gestational	26	(4.48)	10	(8.70)	
Pre-eclampsia	11	(1.89)	2	(1.74)	
Chronic pre-existing	3	(0.516)	0	(0)	
Mode of delivery					0.008*
Vaginal	318	(54.7)	49	(42.6)	
Elective CS	76	(13.1)	19	(16.5)	
Emergency CS	91	(15.7)	26	(22.6)	
Vacuum or forceps	95	(16.4)	20	(17.4)	
Unknown	1	(0.17)	1	(0.87)	

*Statistically significant difference. SD, standard deviation.

Table 2 Guideline entry by indication for hypoglycaemia screening

	Total	Guideline applied	(%)
IDM	68	67	(99)
GDM	66	65	(98)
Type 1 DM	1	1	(100)
Type 2 DM	1	1	(100)
Macrosomic	Unknown	2	
SGA defined by protocol	19	18	(95)
SGA defined by <10th percentile	45	31†	(69)
Other on protocol (wasted, unwell)	Unknown	22	

Groups are not mutually exclusive. †Including 13 not included in the 'SGA per protocol' group, five of whom were also infants of diabetic mothers; note that not all of the 45 SGA infants needed to be screened.
DM, diabetes mellitus; GDM, gestational diabetes mellitus; IDM, infant of a diabetic mother; macrosomic, increased subcutaneous fat, plethora and relatively small head; SGA, small for gestational age.

achieved, we conducted a sensitivity analysis of any breastfeeding and found very similar results; 47 of 106 (44%; 95% confidence interval 34% to 54%) neonates were fed in the first hour with a median duration of 1 h and 10 min between birth and the first feed. Neonates delivered by Caesarean section compared with NVD were more likely to be fed late (RR 1.68, 95% CI 1.18, 2.39, $P = 0.004$; $n = 106$).[13]

The second most common problem was timing of the first blood glucose measurement. The median time between birth and the first blood glucose measurement was 6 h and 34 min and 65 of 106 neonates (61%, 95% CI 51, 71) had glucose measured within 7 h from birth. When babies with an unknown indication for screening were excluded, the median time was 6 h and 15 min and 53 of 80 neonates (66%; 95% CI 56, 75) had glucose measured within 7 h from birth.

Hypoglycaemia incidence (according to positive screening test)

There were 341 glucose levels recorded for 106 neonates, an average of 3.2 per neonate. No blood glucose levels were

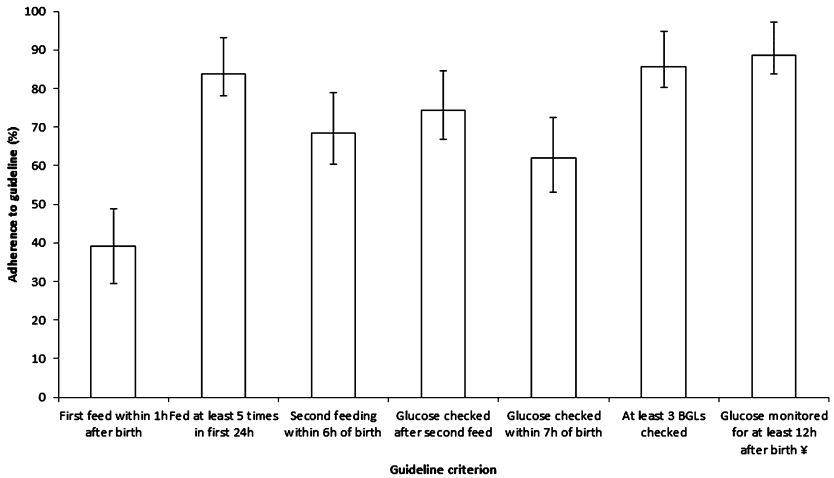

Fig. 1 Percentage adherence to the seven criteria of the RPAH hypoglycaemia guideline. $n = 106$.

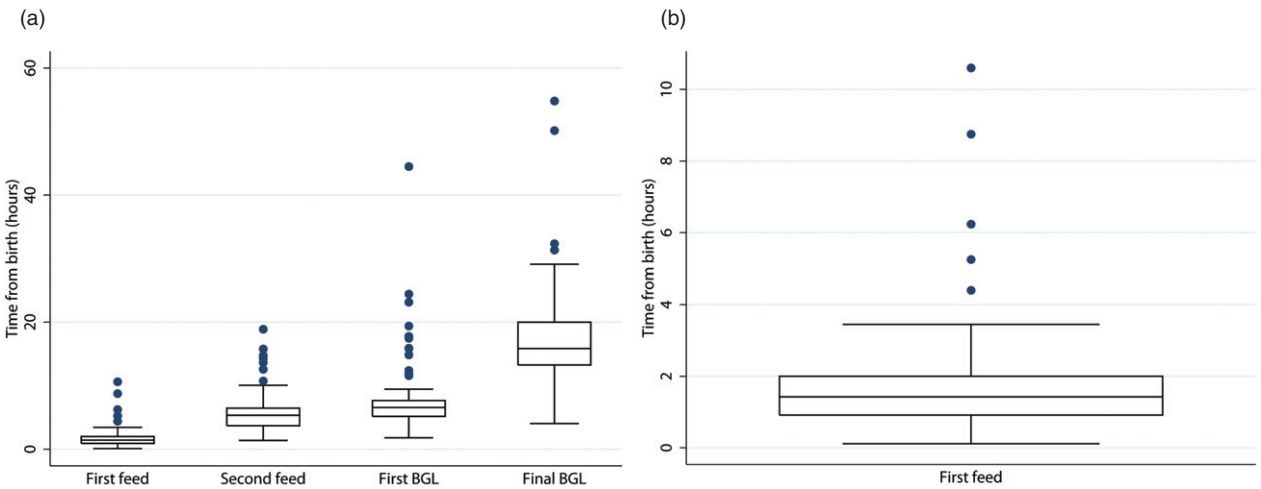

Fig. 2 Distribution of time from birth at which specific guideline actions took place. BGL, blood glucose level. (a) Shows all actions; (b) shows the first feed. According to the guideline, the period between birth and the first feed should be <1 h, the period between birth and the second feed should be <6 h, the first glucose measurement should be performed 30 min after the second feed and glucose monitoring should be continued for at least 12 h after birth.[14] $n = 106$.

≤2.0 mmol/L; 14 (4%) glucose levels from nine (8%) neonates were ≤2.5 mmol/L in the first 24 h and none after this. These screening test glucose levels were not persistently low and so formal laboratory blood glucose testing was not indicated according to the guideline.

Discussion

Our audit of hypoglycaemia screening practices on the postnatal ward found most neonates at risk of hypoglycaemia were screened. The first feed following birth however occurred later than recommended as did the initial blood glucose test. No episodes of clinically detected hypoglycaemia were recorded.

This study provides detailed information on adherence to a hypoglycaemia guideline for a large tertiary referral hospital. Only one previous audit of a hypoglycaemia guideline is available in the literature that examines practice in a Canadian hospital,[11] and there are two published conference abstracts from the UK.[9,10]

Based on the indications for screening we were able to accurately identify, 84 of 86 (98%) SGA and/or IDM infants were correctly screened for hypoglycaemia. It is possible however that the true screening rate for neonates at risk of hypoglycaemia was lower, with wasted, macrosomic and symptomatic neonates missed. In previous audits, 23 of 397 (6%) and 38 of 208 (18%) neonates at risk of hypoglycaemia were missed.[10,11]

Regarding adherence, the guideline was correctly followed for the majority of neonates, with six or seven out of seven criteria met for 60 of 106 (57%), a result comparable with a previous audit that found the hypoglycaemia protocol was followed correctly for 62% of infants.[10] Our results reflect a recent study of neonatal transport centres, with 73% of the guideline adhered to compared with 79% of blood glucose measurements being taken after an intervention to improve adherence.[15] Most neonates however were not fed within the first hour after birth, particularly babies delivered by Caesarean section. This result remained following a sensitivity analysis of feeding criteria, using 'any feed' (codes 1, 2, 3, 4, 5, 6 or expressed breast milk (EBM) or formula) compared with a more stringent nutritive feed (code 5 or 6 or EBM or formula). Early enteral feeding particularly with breast milk, which promotes metabolic adaptation to life outside the uterus[16] and reduces the need for glucose by supplying alternative energy substrates,[17] is recommended by the World Health Organization[18] and early feeding reduces the rate of hypoglycaemia in GDM infants compared with later feeding.[19] A median difference of 26 min is clinically significant, and our previous work shows that neonates receiving their first feed within 1 h of birth are less likely to have feeding morbidity compared with those fed between 1 h and 2 h after birth or later.[13]

Late detection of low blood glucose levels delays treatment and may increase morbidity. As was found in previous audits,[9,11] blood glucose testing was delayed. This remained true when babies with an unknown indication for screening were excluded. The median delay of 34 min we found was however better than delays found in the Canadian audit, where '2 h blood glucose levels' were recorded at an average of 2 h and 44 min for SGA and 3 h and 4 min for LGA infants.[11] However, in our study, the proportion that were tested late, 41 of 106 (39%) was much higher than that in another audit, 23 of 170 (13%).[10] There is little evidence on the optimal timing for the first glucose level; however, current recommendations suggest screening should begin before the second feed, by 6 h of age.[20]

There was no hypoglycaemia detected using the screening blood glucose threshold of ≤2.0 mmol/L in the first 24 h as at RPAH; however, 9% of neonates experienced screening glucose levels ≤2.5 mmol/L that would be consistent with hypoglycaemia at other Australian centres.[4] Though definitions of hypoglycaemia are variable,[21] these rates are lower than previous studies, in which hypoglycaemia incidence as high as 51% for infants at risk.[11,22–24] Our low rates may be explained by several factors including: (i) glucose measurement occurring after feeds, when glucose levels are highest, rather than before feeds as is recommended[25]; (ii) beginning screening at around 6 h of age thus missing the neonatal blood glucose nadir[16]; (iii) good prevention strategies with early and frequent breastfeeding; or (iv) overestimation of glucose levels by the glucometre, which has a sensitivity of only 64.3% and specificity of 75% for levels < 2.0 mmol/L compared with laboratory analysis.[26] It may also be due to failure to identify and measure blood glucose levels of neonates at risk of hypoglycaemia such as wasted neonates.

The strengths of this study include a first Australian audit of hypoglycaemia guidelines and an attempt to include information on feeding. In contrast, this study was conducted retrospectively, and the indication for screening was not available in the medical record for 22 neonates. The total number of macrosomic, clinically wasted neonates and those showing potential signs of hypoglycaemia was not known, which may have caused ascertainment bias in our assessment of screening babies at risk. This limitation would however not affect assessment of timely feeding and blood glucose detection for those neonates being screened. The point-of-care glucometres used may additionally have provided inaccurate glucose readings,[27] which could either underestimate or overestimate the incidence of hypoglycaemia but not affect to whom and when glucose screening was done.

The audit findings have led to changes, including feeding back information on early feeding to staff, increasing midwife numbers in recovery to facilitate breastfeeding after Caesarean section, measuring percentage body fat to identify wasted neonates,[28] auditing blood glucose analysers and including information from the hypoglycaemia guideline on feeding charts to remind staff to screen at the point of care. New research is also emerging that may necessitate updated guidelines.[7] Once these changes are all established, guideline adherence will need to be re-audited.

This audit of hypoglycaemia screening practices at a large tertiary maternity hospital found that identification of SGA and IDM neonates for screening was good; however, that guideline adherence could be improved. Unfortunately, we do not know the extent to which nursing and medical staff were educated and or informed of this guideline when it was implemented, whether they interpreted it the same way and whether they believed it made sense in terms of their clinical experience; however, it is similar to a previous version of the guideline so we expect their knowledge was good. Previous audits indicate adherence may be improved by simplifying the seven-page hypoglycaemia guideline[9] and educating staff.[15] A multifaceted strategy including audit and feedback facilitated by local opinion leaders would also improve guideline adherence.[29] Education should focus on the benefits of early breastfeeding including provision of alternative energy substrates to glucose for brain metabolism and fewer feeding problems and the need to check blood glucose at the second feed.

Acknowledgements

CRG was supported by the Australian National Health and Medical Research Council (NHRMC) Early Career Fellowship #511481. RMT was supported by NHRMC Grant #633003 to the Screening and Test Evaluation Program. AEC is supported by an Australian Postgraduate PhD award. To Cheryl Au, Lucia Wang, Erin Donnelly, Elizabeth Hayles and Meredith Li for their assistance in data collection, the mothers and babies that participated in the study and the midwives that provided insight into the hypoglycaemia screening process.

References

1 Cornblath M, Reisner SH. Blood glucose in the neonate and its clinical significance. *N. Engl. J. Med.* 1965; **273**: 378–81.
2 Tam EWY, Haeusslein LA, Bonifacio SL *et al*. Hypoglycemia is associated with increased risk for brain injury and adverse neurodevelopmental outcome in neonates at risk for encephalopathy. *J. Pediatr.* 2012; **161**: 88–93.

3 Boardman JP, Wusthoff CJ, Cowan FM. Hypoglycaemia and neonatal brain injury. *Arch. Dis. Child. Educ. Pract.* 2013; **98**: 2–6.
4 Harris DL, Weston PJ, Battin MR, Harding JE. A survey of the management of neonatal hypoglycaemia within the Australian and New Zealand Neonatal Network. *J. Paediatr. Child Health* 2009; doi: 10.1111/j.1440-1754.2009.01599.x: 1-8
5 Boluyt N, van Kempen A, Offringa M. Neurodevelopment after neonatal hypoglycemia: a systematic review and design of an optimal future study. *Pediatrics* 2006; **117**: 2231–43.
6 Hay WW Jr, Raju TNK, Higgins RD, Kalhan SC, Devaskar SU. Knowledge gaps and research needs for understanding and treating neonatal hypoglycemia: workshop report from Eunice Kennedy Shriver National Institute of Child Health and Human Development. *J. Pediatr.* 2009; **155**: 612–7.
7 Rozance PJ, Hay WW Jr. Neonatal hypoglycemia – answers, but more questions. *J. Pediatr.* 2012; **161**: 775–6.
8 Cornblath M, Hawdon JM, Williams AF *et al*. Controversies regarding definition of neonatal hypoglycemia: suggested operational thresholds. *Pediatrics* 2000; **105**: 1141–5.
9 Trays GL, Sullivan CL. The dramatic impact of a user friendly hypoglycaemia protocol on admissions to the neonatal unit. *Arch. Dis. Child.Fetal Neonatal Ed.* 2011; **96** (Suppl. 1) BMJ Group, United Kingdom, Fa17–Fa53. doi: 10.1136/archdischild.2011.300164.110
10 Thompson B, Rhodes H, Rackham O. Audit of neonatal hypoglycaemia management. In: Thethy RS, ed. *Paediatric Research Society Autumn Meeting*. Vol. 20. Amsterdam: Elsevier Paediatrics and Child Health, Newcastle upon Tyne, 2009; 255.
11 Croke J, Sullivan M, Ryan-Drover A, Randell E, Andrews W, Aziz K. Two hour blood glucose levels in at-risk babies: an audit of Canadian guidelines. *Paediatr Child Health* 2009; **14**: 238–44.
12 Holmes AV. Establishing successful breastfeeding in the newborn period. *Pediatr. Clin. North Am.* 2013; **60**: 147–68.
13 Carberry AE, Raynes-Greenow CH, Turner RM, Jeffery HE. Breastfeeding within the first hour compared to more than one hour reduces risk of early onset feeding problems in term neonates: a cross-sectional study. *Breastfeeding Medicine* 2013; (in press).
14 Osborn D. Neonatal Hypoglycaemia Guideline. Royal Prince Alfred Hospital, 2010.
15 Diehl-Svrjcek BC, Price-Douglas W, Flagg J. Neonatal glucose testing via prompted intervention during the pretransport phase of care. *Adv. Neonatal Care (Elsevier Science)* 2011; **11**: 340–48.
16 Ward Platt M, Deshpande S. Metabolic adaptation at birth. *Semin. Fetal Neonatal Med.* 2005; **10**: 341–50.
17 de Rooy L, Johns A. Management of the vulnerable baby on the postnatal ward and transitional care unit. *Early Hum. Dev.* 2010; **86**: 281–5.
18 Vallenas C, Savage F. Evidence for the ten steps to successful breastfeeding. World Health Organisation. 1998.
19 Chertok IRA, Raz I, Shoham I, Haddad H, Wiznitzer A. Effects of early breastfeeding on neonatal glucose levels of term infants born to women with gestational diabetes. *J. Hum. Nutr. Diet*. 2009; **22**: 166–9.
20 Hawdon JM. Investigation, prevention and management of neonatal hypoglycaemia (impaired postnatal metabolic adaptation). Vol. 22. 4 edn. 2012; 131–35.
21 Deshpande S, Ward Platt M. The investigation and management of neonatal hypoglycaemia. *Semin. Fetal Neonatal Med.* 2005; **10**: 351–61.
22 Harris DL, Weston PJ, Harding JE. Incidence of neonatal hypoglycemia in babies identified as at risk. *J. Pediatr.* 2012; **161**: 787–91.
23 Metzger B, Persson B, Lowe LP, Dyer AR, Kennedy Cruikshank J. Hyperglycemia and adverse pregnancy outcome study: neonatal glycemia. *Paediatrics* 2011; **126**: 1545.
24 Flores-le Roux JA, Sagarra E, Benaiges D *et al*. A prospective evaluation of neonatal hypoglycaemia in infants of women with gestational diabetes mellitus. *Diabetes Res. Clin. Pract*. 2012; **97**: 217–22.
25 Lucas A, Boyes S, Bloom SR, Aynsley-Green A. Metabolic and endocrine responses to a milk feed in six-day-old term infants: differences between breast and cow's milk formula feeding. *Acta Paediatr. Scand.* 1981; **70**: 195–200.
26 Ho HT, Yeung WKY, Young BWY. Evaluation of 'point of care' devices in the measurement of low blood glucose in neonatal practice. *Arch. Dis. Child. Fetal Neonatal Ed.* 2004; **89**: F356–9.
27 Beardsall K. Measurement of glucose levels in the newborn. *Early Hum. Dev.* 2010; **86**: 263–7.
28 Carberry AE, Raynes-Greenow CH, Turner RM, Askie LM, Jeffery HE. Is body fat percentage a better measure of undernutrition in newborns than birth weight percentiles? *Paediatr. Res.* 2013. (in press).
29 Chaillet N, Dube E, Dugas M *et al*. Evidence-based strategies for implementing guidelines in obstetrics: a systematic review. *Obstet. Gynecol.* 2006; **108**: 1234–45.

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix S1 RPAH Hypoglycaemia Guideline.