The RHINO Project

Early Detection and Referral of Neonates at Risk of Hypoglycaemia

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1. **Background**

Transient low blood glucose levels in neonates are common as the source of glucose at delivery changes from a continuous supply from the mother to the intermittent supply from feeds. It is estimated that ten percent of normal term newborns cannot maintain a plasma glucose concentration above 30 mg/dL (1.7 mmol/L) if their first feeding is delayed for three to six hours after birth.\(^1,2\)

Although transient asymptomatic hypoglycaemia in healthy infants appears to be part of the normal transition to extra uterine life, persistent or recurrent hypoglycaemia can result in neurologic sequelae. It is a condition with high clinical risk as severe hypoglycaemia deprives brain of essential “fuel” and can lead to seizures and permanent neurological impairment.\(^1,3\) What level and duration of hypoglycaemia is damaging is matter of debate and one that needs further research. The concept of a range, operational threshold has been proposed by Cornblath.\(^3-5\)

This should not divert from the fact that this is a high risk area as in neonates with persistent hypoglycaemia or symptomatic hypoglycaemia delayed treatment can result in neurological sequelae raising the potential for neurodisability, as well as death of the baby.

NHS Litigation Authority (NHSLA) figures obtained by the Guardian show that in England in the past decade, it has received 79 claims for damages of harm to babies relating to undetected or untreated hypoglycaemia. Of those, 19 were closed with no compensation. It has paid damages of between £300,000 and more than £7m in 19 other cases and is defending 41 other similar actions. Seven of the 19 settled cases have each involved damages of more than £6m.\(^6\)

In 2011, a report from the American Academy of Pediatrics (AAP) discussed the challenge of defining clinically significant hypoglycaemia based on blood glucose concentrations \(^4\). This report noted that the generally adopted level used to define neonatal hypoglycaemia is less
than 47 mg/dL (2.6 mmol/L) and proposed an operational threshold of 45 mg/dL (2.5 mmol/L) as a target glucose level prior to routine feeds. There is need for robust practice involving monitoring of at risk newborns and early identification and treatment of those detected to have low blood sugars as described above for the reasons mentioned. In Princess Anne Hospital Southampton there are guidelines for the management of at risk babies covering monitoring, referral and treatment.

2. The Problem

NHSLA Audits were carried out in July 2012 looking specifically at postnatal management of neonates at risk of hypoglycaemia as well as inpatient management of neonates with hypoglycaemia admitted to the neonatal unit.

A total of 81 babies were identified as being at risk based on the criteria defined in the guideline -Hypoglycaemia Prevention and Management Postnatal Ward Version 2.
The RHINO Project
Version 3
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The audit on postnatal management identified the following:

- 32% of postnatal babies having sugar monitoring were on the incorrect proforma.
- 11% of neonates were not managed as per the existing guideline in terms of appropriate timings of sugar monitoring.
- 11% of neonates at risk of hypoglycaemia on the postnatal ward did not have a proforma in the notes raising the possibility they were not monitored.
- Postnatal neonates with hypothermia (i.e. temperature less than 36.5°C) were missing out on having blood sugars.
- Babies with hypothermia who improved and had normal sugars were having unnecessary sugar monitoring.

A total of 32 babies were monitored and managed as per the in-patient hypoglycaemia guideline with 6 admissions from the postnatal ward as defined by blood sugar in the guideline Hypoglycaemia-management of the high risk infant on neonatal unit version 2.

The audit for in-patient management identified the following:

- 4 of the babies with sugars less than 2.6 might have had earlier referral, review by the paediatric SHO, and admission to the neonatal unit by following the guideline.
3. Analysis of the issues

In order to understand the difficulties with monitoring and referral feedback was taken from the midwifery team, nursery nurses and ST1-3 trainees.

Table 1

<table>
<thead>
<tr>
<th>Areas identified as being problematic were-</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Difficulties getting hold of the neonatal SHO to review babies with low blood sugars.</td>
</tr>
<tr>
<td>2. The lack of consistent advice on management once a baby was identified as being hypoglycaemic with different approaches.</td>
</tr>
<tr>
<td>3. The guideline being exhaustive (31 pages) and long with appendices at the end of the guideline.</td>
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<tr>
<td>4. The presence of 2 similar looking proformas which had different standards for management and referral of at risk babies.</td>
</tr>
<tr>
<td>5. Difficulties finding the correct guideline on the trust intranet as there are 3 different guidelines on the intranet dealing with management of neonates with hypoglycaemia.</td>
</tr>
<tr>
<td>6. Lack of appropriate education regarding the guideline at induction for trainees.</td>
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</tbody>
</table>

A multidisciplinary questionnaire survey (Table 2) covering the midwifery team, nursery nurses ST1-8 doctors and neonatal consultants was performed in the month of September 2012 to evaluate knowledge with regards to the guideline addressing referral of at risk neonates with hypoglycaemia. 4 multiple choice questions (with only one correct answer) were evaluated with 34 participants over a 1 week period in September 2012.

Q1. When should a neonatal SHO/ANNP review a baby with a low blood sugar on the postnatal ward?

Q2. When should a neonate with hypoglycaemia be admitted to the neonatal unit?

Q3. For a well-baby a blood sugar should be done if there temperature falls below ….C?

Q4. What should be done for a baby with symptoms of hypoglycaemia and a sugar of 2.4mmol/litre?
Table 2 Responses to Multidisciplinary Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Consultant (n)</th>
<th>ST1-8 (n)</th>
<th>Midwife (n)</th>
<th>Nursery Nurse (n)</th>
<th>SHCA (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>100% (4)</td>
<td>28.5% (7)</td>
<td>71.4% (7)</td>
<td>50% (8)</td>
<td>12.5% (8)</td>
</tr>
<tr>
<td>Q2</td>
<td>100% (4)</td>
<td>57.1% (7)</td>
<td>85.7% (7)</td>
<td>75% (8)</td>
<td>50% (8)</td>
</tr>
<tr>
<td>Q3</td>
<td>100% (4)</td>
<td>28.5% (7)</td>
<td>57.1% (7)</td>
<td>100% (8)</td>
<td>62.5% (8)</td>
</tr>
<tr>
<td>Q4</td>
<td>100% (4)</td>
<td>28.5% (7)</td>
<td>28.5% (7)</td>
<td>0% (8)</td>
<td>0% (8)</td>
</tr>
</tbody>
</table>

Results - The survey revealed lack of familiarity with the guideline across the board. There were an equal number of respondents in each group. In particular Questions 1 and 4 which focus on the need for early review were answered very poorly by all groups.
4. The RHINO Project

After the audit, and feedback from staff, the following was implemented-

1. The old incorrect hypoglycaemia proformas (1500 approximately) were removed from all clinical areas where care of at risk neonates was taking place.

2. The correct hypoglycaemia proforma was reproduced with a colour coded traffic light system helping staff stratify the risk of at risk neonates based on their bedside glucose measurements. Hypothermic babies were to have blood sugars done but if normal and hypothermia resolved monitoring could be stopped. (Appendix 1)

3. RHINO Project-In order to cascade education to large multidisciplinary groups of staff different fields and groups an innovation of using a catchy acronym to help increase curiosity and cascade education was proposed. The acronym chosen was RHINO-Referral/Review for Hypoglycaemia detected during Newborn Observations.

4. Posters were produced with this catchy acronym (Appendix 1). These posters had the criteria for identifying neonates at risk of hypoglycaemia, and the new colour coded hypoglycaemia proformas. They also used a magnified version of the early referral traffic light system to highlight cut-off levels for capillary glucose at which intervention was needed. They helped condense and simplify the 31 page guideline into a bedside algorithm.

5. The posters prompted personnel looking after at risk babies to evaluate if they were using the correct proforma to perform capillary glucose measurements on at risk babies.

6. The traffic light system emphasized action based on bedside glucose measurements in particular when the baby should be seen by a doctor and when it needs to be admitted to the NNU without delay explaining management to the parents. There was a key emphasis on early recognition, review, action and documentation.

7. The green and yellow traffic lights empower our nursery nurses and midwifery colleagues to manage the baby without separation from the mother.
8. The posters were eye catching, put up in all clinical areas where bedside sugar monitoring on neonates was being performed, and easily accessible to all relevant staff.

9. The RHINO Project was presented as a neonatal audit on the 5th of November and then to the Obstetric governance working group on the 8th of November 2012; it was formally implemented in December 2012. Between the 1st and 9th of December 2012, teaching sessions were carried out on postnatal wards during handover to bring attention to the introduction of these posters and to reinforce the importance of significant cut-off levels for intervention and early referral of hypoglycaemic babies for review. An email was also disseminated via midwifery lead to ensure all midwifery staff is informed of the changes.

10. As medical staff rotates, and new midwifery staff is recruited nursery nurses acted as Nurse Champions for cascading the RHINO project. They acted as the continuity in the education process. Every opportunity was used to highlight the importance of early identification (1 sugar below 2 needs a review) and referral (2 sugars below 2 admit to SCBU).

5. Quality Improvement Project

The RHINO project was implemented as a quality improvement exercise with a view to studying whether we would improve the quality of care for neonates at risk of hypoglycaemia. It was decided to audit whether it had made any impact at 1 and 4 months through re-audits of the postnatal ward management of hypoglycaemia guideline. This time line was chosen to ensure compliance with NHSLA level 3 standards. In addition 6 months into the project all admissions to the neonatal unit from the postnatal ward with hypoglycaemia were to be audited to see if referral was made as stated in the guideline and posters. The concept involved a classical PDCA cycle approach.
5.1 Figure 2 Timeline

Time Line

- Audit July 2012
- Neonatal Audit Nov 2012
- Combined Neonatal-Obstetric Audit Nov 2012
- Governance Nov 2012
- Posters in clinical areas
- Education Dec 2012

5.2 Figure 3 Processes

THE RHINO PROJECT
Referral/Review for Hypoglycaemia in Newborn Observations
6. Management of neonates at risk of hypoglycaemia on postnatal ward

Management of neonates at risk of hypoglycaemia was audited in the months of January and April of 2013 by Dr Alok Sharma using the SNAP 10 tool. A repeat audit was done in July 2014 by Dr Emily Charkin with audits planned annually. The results summarised below show complete eradication of use of the old incorrect proforma. There was also consistent improvement in the monitoring, and interventions and management of at risk neonates.

(Table 3)

Ongoing education of new medical trainees is done at induction, and through the nursery nurses who perform baby checks with them soon after.

Table 3

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Standard</th>
<th>July 2012</th>
<th>Jan 2013 (n)</th>
<th>Apr 2013 (n)</th>
<th>July 2014 (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of appropriate pathway in appendix</td>
<td>100%</td>
<td>68%</td>
<td>100% (14)</td>
<td>100% (14)</td>
<td>100% (15)</td>
</tr>
<tr>
<td>Infants ‘at risk’ of hypoglycaemia to have monitoring proforma completed</td>
<td>100%</td>
<td>89%</td>
<td>100% (14)</td>
<td>100% (14)</td>
<td>100% (15)</td>
</tr>
<tr>
<td>Time to first feed and skin to skin documented in notes</td>
<td>100%</td>
<td>86.6%</td>
<td>100% (14)</td>
<td>100% (14)</td>
<td>100% (15)</td>
</tr>
<tr>
<td>Was an at risk proforma present in the notes</td>
<td>100%</td>
<td>89%</td>
<td>100% (14)</td>
<td>100% (14)</td>
<td>100% (15)</td>
</tr>
<tr>
<td>Were sugars measured at appropriate times</td>
<td>100%</td>
<td>89%</td>
<td>100% (14)</td>
<td>100% (14)</td>
<td>93% (14)</td>
</tr>
</tbody>
</table>

7. Audit of management of infants admitted to neonatal unit due to hypoglycaemia January 1st-June 30th 2013

In the original audit in July 2012 4 infants had multiple low sugars prior to intervention and admission to the neonatal unit. In order to assess impact of the RHINO project it was also
necessary to audit whether infants admitted to neonatal unit due to hypoglycaemia were being reviewed and referred in a timely manner from the postnatal ward. Dr Tiffany Fan performed an audit of all neonates admitted to the NNU with neonatal hypoglycaemia from the postnatal ward (January-June 2013). This was 12 neonates.

Table 4

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Standard</th>
<th>Result (n 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All infants with blood sugar &lt;2 should be reviewed or discussed with neonatal doctor or ANNP</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Infants with two blood sugar &lt;2 should be admitted to neonatal unit</td>
<td>100%</td>
<td>91%</td>
</tr>
<tr>
<td>Asymptomatic infants should be fed “one day ahead” or receive IV 10% dextrose</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Symptomatic infants should receive IV 10% dextrose (n=3)</td>
<td>100%</td>
<td>66% *</td>
</tr>
</tbody>
</table>

All neonates with one sugar less than 2 were reviewed or discussed with a neonatal doctor. For neonates with 2 sugars less than 2 11/12 neonates were admitted and 1 was not. This case was reviewed at the departmental audit meeting and there was a discrepancy in the sugars measured bedside and the gas machine which showed sugars in the normal range. Eventually the baby was admitted for further management but was asymptomatic throughout the process. This has also helped identify how bedside glucose monitors may not be as reliable when blood sugars are low. There is evidence that radiometer gas machines may be more accurate.7
We are now recommending where possible that blood sugars of postnatal ward babies less than 2.6 are checked on the neonatal gas machine. We are looking into the possibility of purchase of a gas machine for the postnatal wards. This is to try and improve the accuracy of bedside sugar monitoring in neonates. All neonates reviewed/admitted to the neonatal unit (symptomatic or otherwise) must have blood sugars cross checked on the gas machine.

8. Has the intervention improved knowledge?

A repeat survey of knowledge was carried out in July 2014 by Dr Emily Charkin evaluating the same questions as in 2012. This was to determine if we were keeping knowledge levels regarding the postnatal hypoglycaemia protocol up, as well as to raise the awareness of the RHINO project.

Repeat Questionnaire Survey July 2014

A questionnaire survey covering the midwifery team, nursery nurses ST1-3 doctors and neonatal consultants was performed in the month of September 2012 to evaluate knowledge with regards to the guideline addressing referral of at risk neonates with hypoglycaemia.

4 multiple-choice questions (with only one correct answer) were evaluated with 34 participants over a 1-week period in September 2012.

Q1 When should a neonatal SHO/ANNP review a baby with a low blood sugar on the postnatal ward?
Q2 When should a neonate with hypoglycaemia be admitted to the neonatal unit?
Q3 For a well baby a blood sugar should be done if there temperature falls below .... C?
Q4 What should be done for a baby with symptoms of hypoglycaemia and a sugar of 2.4 mmol/litre?
The results are shown in Table 5. There were improvements from 2012 especially amongst the nursery nurses and midwifery team but for the junior doctors there was need for improvement.

Table 5

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Midwives/nursery nurses % correct answer (n=8)</th>
<th>Doctors % correct answer (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>100% (8)</td>
<td>87% (7)</td>
</tr>
<tr>
<td>Q2</td>
<td>87% (7)</td>
<td>100% (8)</td>
</tr>
<tr>
<td>Q3</td>
<td>75% (6)</td>
<td>12% (1)</td>
</tr>
<tr>
<td>Q4</td>
<td>63% (5)</td>
<td>50% (4)</td>
</tr>
</tbody>
</table>

In order to raise the profile and address education amongst the junior doctors a scenario has been incorporated into the multidisciplinary neonatal simulation programme at Southampton regarding neonatal hypoglycaemia which will be run point of care and early in the programme just after the new doctors join.

9. Reducing Term Admissions to the Neonatal Unit

In University Hospitals Southampton alone neonatal hypoglycaemia accounts for nearly 5% of the admissions to the neonatal unit. (Table 6) These may be potentially preventable admissions with early intervention. These babies have to be separated from their mothers impacting bonding and breastfeeding. There is also a knock on effect on the neonatal unit as these neonates are admitted to SCBU where occupancy regularly crosses 100%. This impacts the movement of babies from ITU/HDU resulting in lack of capacity for neonates
who need it. There has to be a balance between being able to manage neonates with neonatal hypoglycaemia and admission to the neonatal unit for babies who need treatment. The RHINO project allows for early intervention through risk stratification of babies. Neonates under the Red traffic light are at highest risk. Early intervention and appropriate referral is initiated to prevent admission where possible, while babies in the Green and Yellow group are managed with their mothers on the postnatal ward. It prompts urgent review and admission of all symptomatic babies.

The key question is

Does the initiative help prevent the admission of term and near term neonates who could be managed with their mothers on the postnatal ward?

Are we admitting only babies who actually need admission to the neonatal unit?

- Early intervention (skin to skin care, early feeding, keeping babies warm) should theoretically help with management of neonatal hypoglycaemia.
- In the month of July 2012, 413 babies were delivered in Princess Anne Hospital and its catchment. 19.6% of these babies were at risk of hypoglycaemia. 36% actually had a blood sugar less than 2.6 at some point on the postnatal ward. 7.4% were admitted to the neonatal unit. In the same month In July 2012 11% missed out on sugar monitoring.
- In July 2012 16% of neonates at risk of hypoglycaemia missed out on skin to skin care.
- In July 2012 16% did not have a feed within the 1st hour.

We have improved upon these issues.

We are currently evaluating what proportion of our term and near term admissions who are managed on the postnatal ward for hypoglycaemia and hypothermia are actually admitted to the neonatal unit. We are collecting this data retrospectively for the years 2012 and 2013. This is being done by Dr Gemma Watts. Denominator data regarding mothers meeting at risk screening criteria is being collected through the obstetric department for the same period.
10. Taking the RHINO forward-RH\textsuperscript{2}INO

A retrospective audit for the year 2014 is being carried out to evaluate management of neonates admitted to the neonatal unit. (Dr Preshan) This will help inform us of strategies for managing asymptomatic neonates on the postnatal ward. The RHINO poster is being updated to incorporate early intervention with regards to neonates who become hypothermic in the labour and postnatal wards. The intention is to develop a single video with the learning media team in University Hospital Southampton to supplement the poster raising the profile of the sick new-born addressing sepsis, hypothermia and hypoglycaemia. A proposal for this was put forward to the regional innovation fund (NHS England) by Dr Alok Sharma in 2014 but was not accepted.

11. Conclusion

The RHINO project highlights how multidisciplinary education can be cascaded through a simple replicable innovation with a human touch. We have been able to demonstrate improvements in knowledge, and practices resulting in improvements in quality of care, and service provision. This approach can help mitigate medico-legal risk while having a potential impact on NHS indemnity. The key question is whether we can actually produce an impact reducing preventable admissions to neonatal units across the UK, using such an approach. Neonatal hypoglycaemia is a universal issue for babies born all over the country. There were 729,674 live births in England and Wales in 2012, increasing slightly (by 0.8%) from 723,913 in 2011. The RHINO project represents an example of a simple cost-effective reproducible high impact intervention which has worked for us.
References


6. ‘NHS Litigation Authority sets aside £235.4m to settle 60 cases in which hospital staff failed to spot hypoglycaemia in newborns’, Guardian, 9 April 2012
   http://www.guardian.co.uk/society/2012/apr/09/nhs-blunders-babiesbrain-damage
   accessed 28th August 2013

Appendix 1

**PROJECT RHINO**

Referral/Review for Hypoglycaemia detected during Newborn Observations

### Background

Hypoglycaemia, if sustained, may affect acute cerebral function and result in adverse long-term neuro-developmental outcome. Hypothermia is often associated with hypoglycaemia and or may be a sign of other illness i.e. sepsis.

Missed cases’ late referral can have profound impact on the neonates resulting in:
1. Unexpected admission to the NNU.
2. Neurological sequelae.

### Which babies need BLOOD SUGARS?

- Maternal Diabetes (gestational or pre-existing)
- Birth weight < 2.5kg / > 4.5kg
- Babies who become cold < 36.5°C
- Preterm < 37/40
- IUGR < 10th centile
- Polycythaemia
- Sedation through jaundice or maternal medication (i.e. B blockers, Labetalol)
- Babies with any signs of illness, especially lethargy, grunting, jitteriness
- Perinatal hypoxia
- Rhesus disease
- Family history of specific metabolite disorder

### Traffic light system for early referral

- **Green** (Sugar ≥ 2.6)
  - In asymptomatic ‘at-risk’ babies, consider alternate pre-feed Blood sugar measurements (3 in 24 hours)
  - Temperature < 36.5°C
  - Please measure a blood sugar and follow traffic light.

- **Yellow** (Sugar 2-2.5)
  - With symptoms
    - Urgent Review/Admit NNU
  - No symptoms
    - Continue feeding support on postnatal ward

- **Red** (Sugar < 2)
  - With symptoms
    - Urgent Review/Admit NNU
  - No symptoms
    - One Sugar Below 2.0mmol/l
    - Needs a review
    - Two sugars below 2.0mmol/l
    - Admit to NNU
  - Blood sugar less than 2.0mmol/l

### Are you using the correct proforma?

- It has colour coded traffic light on the back.

### PROJECT RHINO

An audit done in July 2012 identified that we were using the incorrect hypoglycaemia proforma.

32% of postnatal babies having sugar monitoring were on the wrong proforma.

We missed 11% of neonates at risk of hypoglycaemia on the postnatal ward.

Postnatal neonates with hypothermia (i.e. temperature less than 36.5°C) were missing out on having blood sugars.

Project RHINO aims to identify, manage and refer hypoglycaemic and hypothermic neonates early.
Appendix 2 Poster in Clinical Area

Appendix 3 Deming's PDCA Cycle (Plan Do Check Act)

Appendix 4
Website link:  http://www.wonepedu.com/NEST.HTML

The Rhino Project-1.pdf
The RHINO Project

University Hospital Southampton Clinical Audit and Effectiveness Conference 2013: Best Audit and Oral Presentation
Wessex Notable Practice Awards 2013: Highly Commended Innovation
Wessex Annual Medical Education Conference 2013: ‘Runner Up Poster Category’
Health Education Wessex nominated Education and Training Innovation Champion of the Year 2014
Submission to GMC as example of good practice 2014