Countess of Chester Hospital NHS
NHS Foundation Trust

Position Paper – Neonatal Unit Mortality

2013 - 2016

1.0 Executive Summary

The purpose of this paper is to provide the Executive Team with key mortality data and supplementary narrative to enable an assessment of the patient safety concerns identified by the neonatal clinicians relating to an apparent increase in the number of neonatal deaths during 2015/16 and 2016/17 (year to date).

2.0 Background

The Trust provides a range of paediatric and neonatal services. The neonatal unit has 20 cots and provides critical care, high dependency care, special care and transitional care for newborn babies.

The Trust provides a Local Neonatal Unit service (Level 2 care) providing short term ventilation. The Neonatal Unit provides care to 27/40 gestation; any baby born below this criterion is transferred to the nearest Level 3 unit. The critical care and high dependency care cots are interchangeable and can therefore flex according to the needs of the unit.

In June 2015, the Neonatal Unit identified 3 deaths during a 2 week window. These cases were subject to individual case review by the specialty. Due to these deaths occurring within short succession, and that no neonatal deaths had been reported by the Neonatal Unit during 2014/15, an additional Executive Serious Incident Panel was held on 3 July 2015. The summary of care provided to the 3 babies can be found in Appendix 1.

A comprehensive case review was undertaken in February 2016 following the deaths of 10 neonates (including one who died shortly following transfer). A Consultant from Liverpool Women's Hospital was present during this review (See Appendix 2).

2 of the neonatal deaths reported in 2015/16 occurred in February and March 2016 and are therefore missing from this comprehensive case review.

An action plan was drafted by the specialty. Within this, a further 'deep dive' was undertaken by the Neonatal Unit Manager to consider the nursing interventions prior to the neonatal death and included a further review of the health record, vital signs monitoring, feeding charts and blood gas results (See Appendix 3).

This nursing review led to further discussions regarding other possible, contributory factors including the medical devices used, infection control practices and staffing establishment and skill-mix.

These reviews were not received at the Trust's Quality, Safety and Patient Experience Committee.

In June 2016, following the death of triplet 1 and 2, the specialty highlighted their concerns regarding an apparent increased mortality rate. The babies have been subject to a case review; as an outcome from this, all x-rays undertaken are to undergo Radiology peer review.

Using the data available from the Badgernet database, this analysis aims to investigate the validity of these concerns.

The analysis has three aims:

1. To review the **significance** of any increase in mortality levels in the Neonatal Unit during 2015/16 and whether this represents normal variation or a significant change that breaks with long term trends.
2. To evaluate **activity** levels in the NNU during 2015/16 as a possible contributory factor. Was the unit under more pressure of work during the period?
3. To evaluate certain measures of **acuity** in NNU during 2015/16.
   Was the condition of neonates admitted to the unit more acute than in previous years?

3.0 Key Issues/Gaps in Assurance

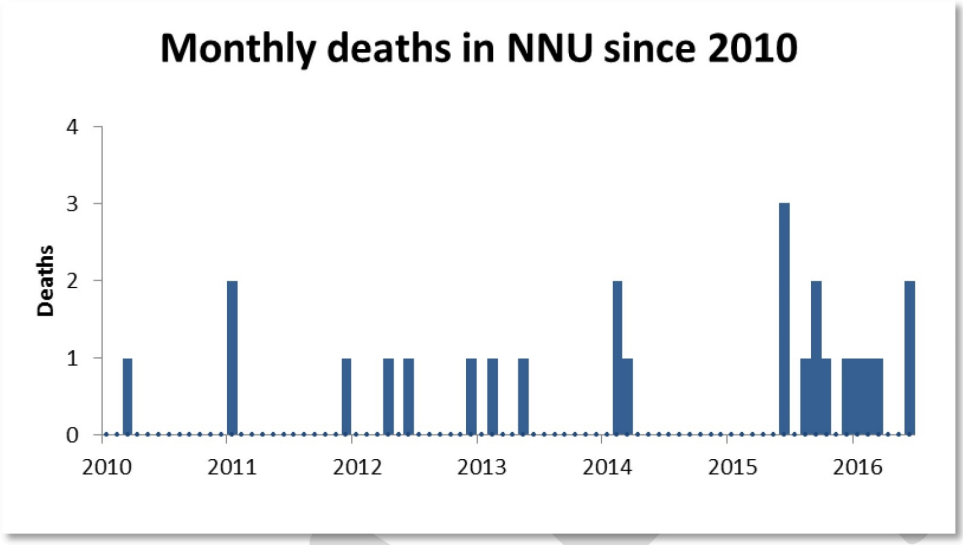
3.1 Mortality Data

Data discrepancies between the differing systems in place has led to a number of challenges in obtaining an accurate account of the Neonatal Unit activity over time. Having reviewed the outputs from Meditech, BadgerNet (neonatal specific electronic patient record), HED (Healthcare Evaluation Data) and that recorded within the Trust's Bereavement Office, the actual number of deaths occurring within the Neonatal Unit recorded from January 2010 up to and including June 2016 is as follows:

Actual number of deaths in the Neonatal Unit:

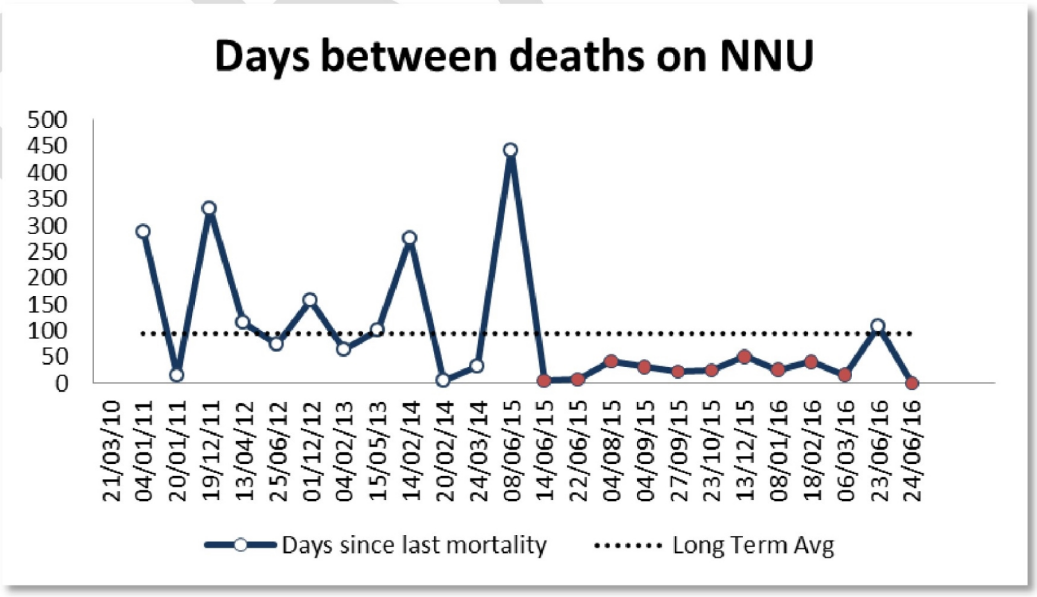
Year	Number of NNU Deaths
2010	1
2011	3
2012	3
2013	2
2014	3
2015	8
2016 YTD	5
Total	**25**

Since July 2016, there has been an increase in the number and frequency of mortalities on the Neonatal Unit which is visible in the clustering of deaths on the far right of the graph below as compared to the relatively sparse incidence of previous years.

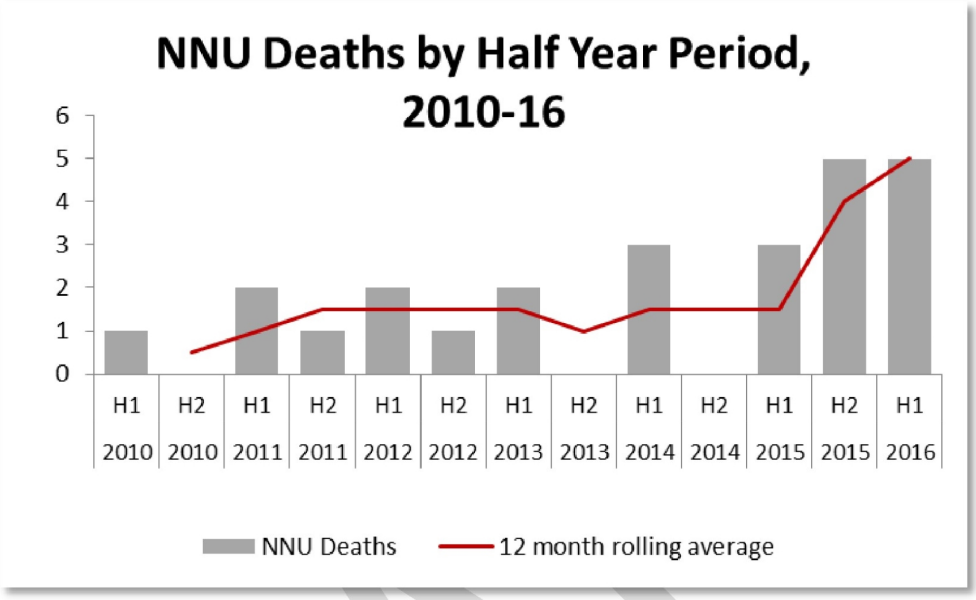


Another way to visualise the data is to plot the time between deaths on the Neonatal Unit. The key points of the graph below are:

- The long term average since March 2010 is a space of **94.8** days between deaths
- From June 2015, this fell to an average space of **31.3** days between deaths.
- 11 out of 12 deaths after 08/06/14 were below the long-term average number of 'days since last mortality'.



Finally, if deaths on the Neonatal Unit are analysed per half year period, there is a steady mortality rate until H2 2015. The 12 month rolling average shows a sudden increase at this point which continues into the first half of 2016.

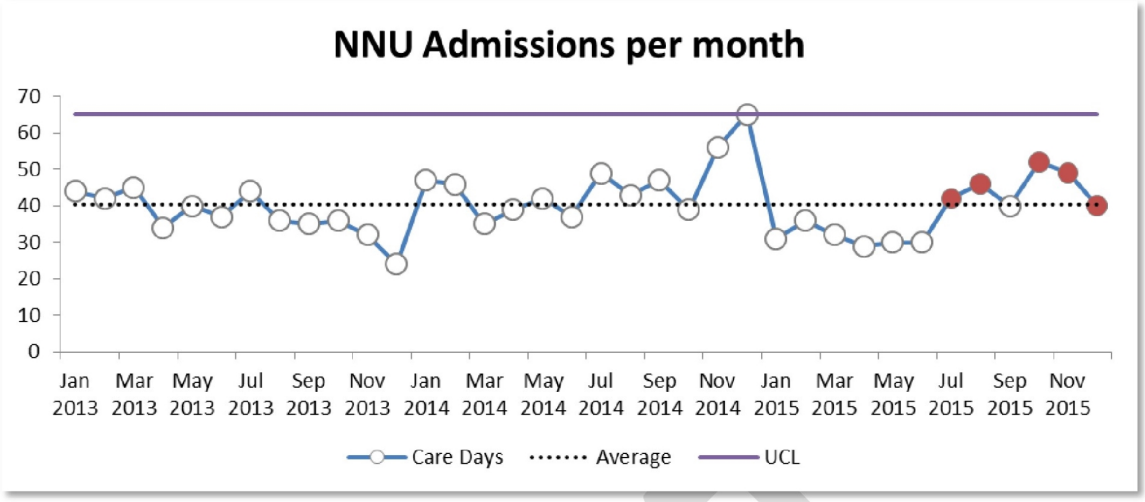


To give context to this apparent increase in the mortality rate reported on the Neonatal Unit, the unit's activity and acuity data has been obtained.

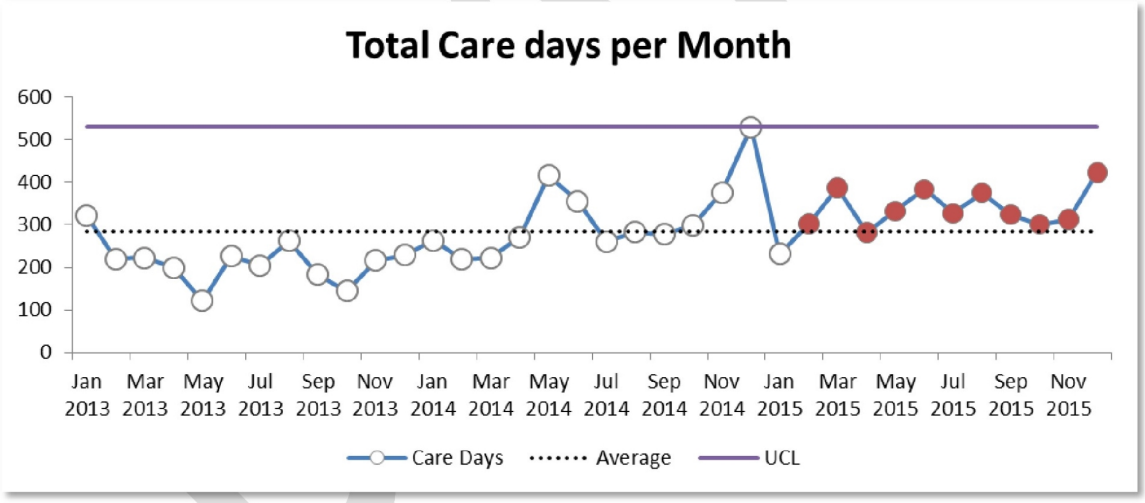
The number of admissions to the Neonatal Unit:
To what extent does the increase in mortality levels reflect a general increase in activity in the NNU? We can get a sense of the pressure of work by looking at monthly admission numbers and 'Total Care Days' per month.

Taking admission numbers first, the graph below shows that over the second half of 2015, the Neonatal Unit experience higher than average admissions for five out of six months.

Higher admissions may have been a contributing factor but it should be noted that 2014 saw higher admission numbers, including a significant peak in December, without a similar increase in the number of mortalities.

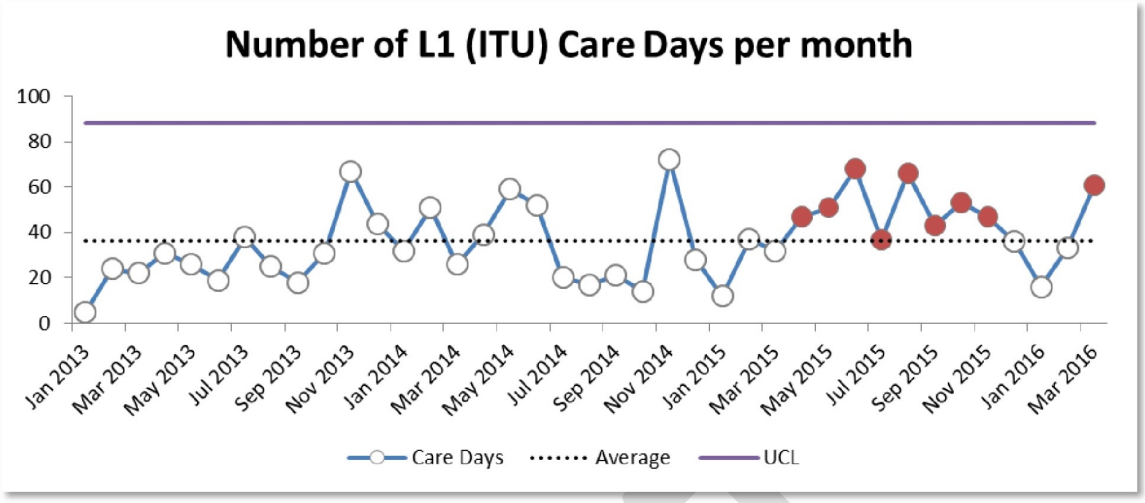


Another way to measure the overall level of work is to compare the number of patient care days per month in the NNU. Looking at the graph below, it is clear that every month since February 2015 has seen a greater number of care days than the long term average. This suggests that the NNU has been busier and workloads have been higher. Again, this needs to be qualified by the fact that there have been similar (and greater) peaks in 2014 without a corresponding increase in mortality levels.

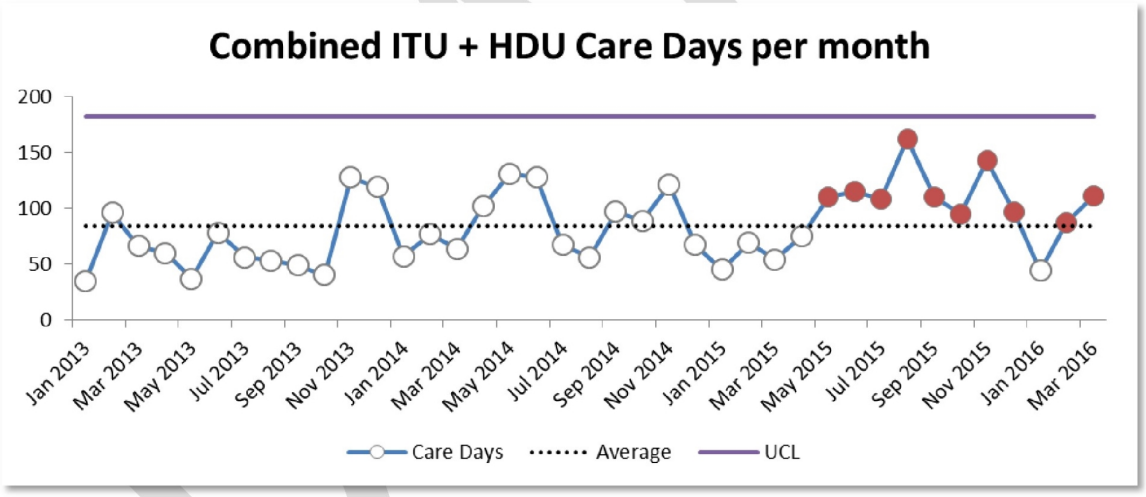


It is also possible that the increase in mortality numbers over the period may reflect increased levels of patient acuity. One measure of this is looking again at 'Total Care Days' but specifically at the highest levels of patient care: Level 1* representing intensive care 'Care Days' and Level 2 representing high dependency 'Care Days'. 2015/16 shows a sustained increase in the average number of care days at L1. Eight consecutive months are higher than average at L1.

*For HRG purposes, intensive care is level 1, high dependency care is level 2 and special care is level 3

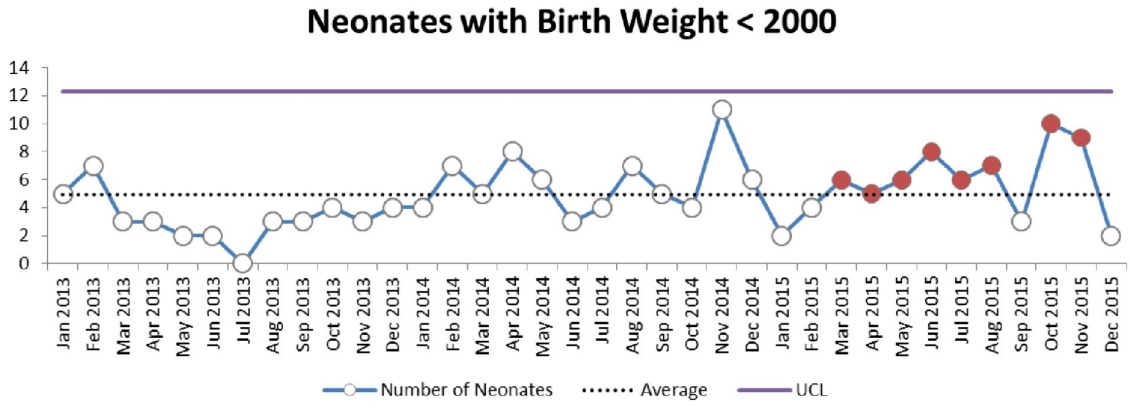


The increase in high acuity care days is evident when Level 1 (intensive care) and Level 2 (high dependency) care days are combined per month. Between May 2015 and March 2016, only one month shows a drop below the long term average. There have been two and three month fluctuations above the average in previous years, but nothing to match the sustained increase seen after May 2015.



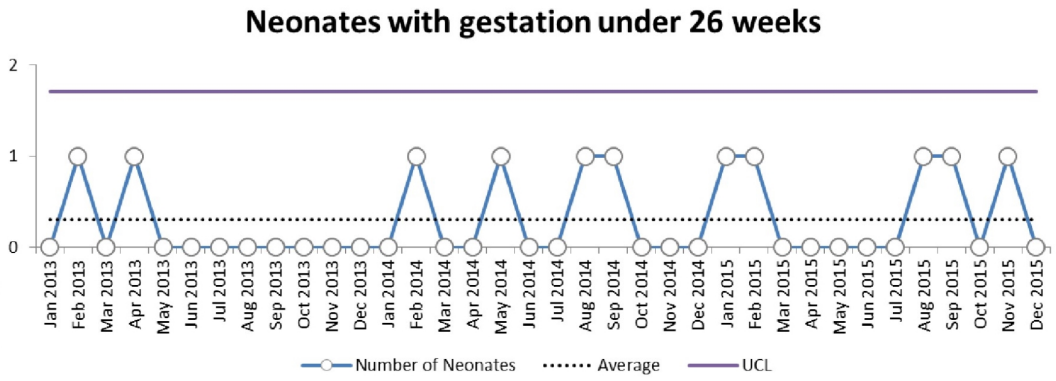
Birthweight of neonates on admission to the Neonatal Unit:

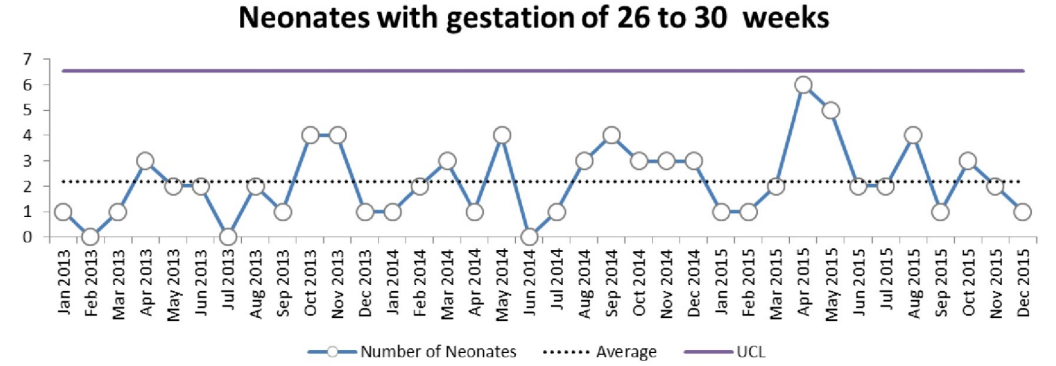
Another measure of acuity is neonatal birth weight. Monthly figures show that between March and December 2015 there was a higher than average number of babies born in the lowest two categories of weight in all but two months. This would correlate with the increased demand for high level care over the same period.

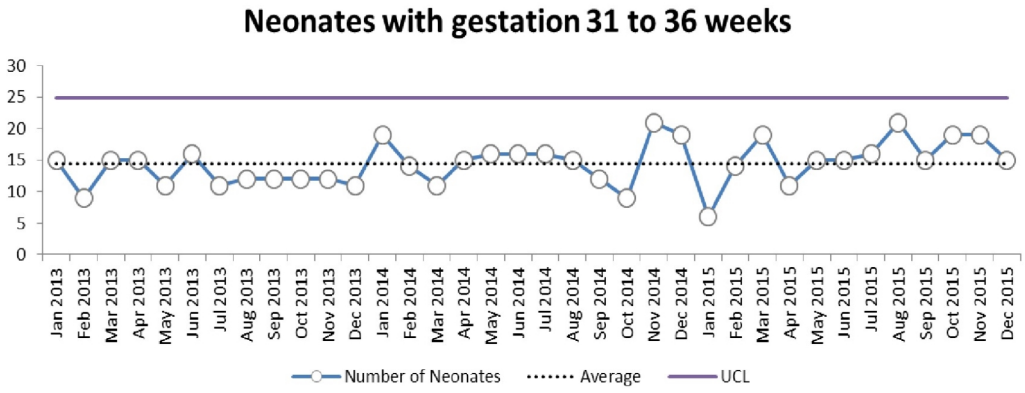


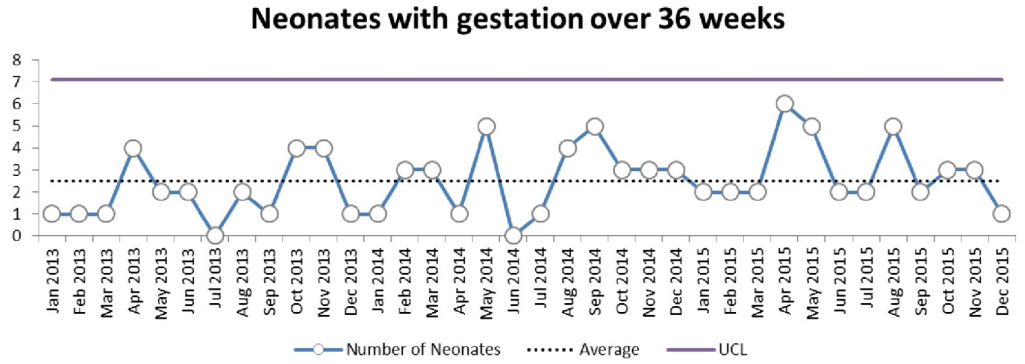
Gestation of neonates on admission to the Neonatal Unit:

Gestation periods were also analysed to assess whether there were greater levels of prematurity that coincided with the period of greater mortality levels seen in the second half of 2015. This does not seem to be the case for admissions in the most severely premature categories (below 26 weeks and between 26 and 30 weeks) but there was an eight month run of higher than average admissions at 31-36 weeks.









3.2 Incident Reporting – Neonatal Deaths and Sudden Deterioration

Analysis of Datix for incidents reported confirms that there were incident reports logged regarding various aspects of care in 10 of the 11 neonatal deaths reported in 2015/16. The death of two babies (CC Child D nd CC I&S was subject to a NPSA Level 2 patient safety investigation and this included a review of the antenatal care and labour.

Of the 16 neonatal deaths identified during the 36 month period up to and including June 2016, 8 (50%) are from 'out of area' with 6 Mother's being resident in I&S **.

Of the 16 neonatal deaths identified during the 36 month period up to and including June 2016, 5 (31%) are multiple pregnancies, predominantly of twins**.

**The neonatal deaths include two neonates from a set of triplets from the same Mother, resident in I&S

The specialty have identified that during 2015/16, a further 3 neonates died shortly after transfer to a Level 3 unit. These are CC I&S, CC I&S and CC Child K. The specialty have also identified a further 4 neonates who experienced a sudden deterioration in their condition during the period January – June 2016 (2015/16 = 1; 2016/17 = 3); none of these had been reported via the Datix incident reporting system and therefore these require further case review. These are CC I&S, CC Child M, CC Child Q and CC Child N.

As the specialty does not routinely capture these events, neonates transferred out of the Neonatal Unit to level 3 care have been considered within this review. This has identified that during the 36 month period up to and including June 2016, there were 4 neonates who experienced a sudden deterioration in their condition. These are CC I&S CC Child Q, CC I&S and CC Child H

3.3 Patient Experience

Analysis of Datix for PALS contacts and formal complaints during the 36 month period up to and including June 2016 identifies no concerns raised.

3.3 Coroners Referrals & Inquests Opened

Analysis of Datix for Coroners inquests opened during the 36 month period up to and including June 2016 confirms 1 inquest [CC I&S] which the conclusion was death by misadventure following developing pulmonary haemorrhage during intubation for a neonatal network transfer. This death occurred on 24 March 2014 was subject to a NPSA Level 2 patient safety investigation.

For 2015/16, there are 2 inquests opened with no date yet scheduled. Both cases were subject to neonatal case review and were discussed at the Executive Serious Incident Panel meeting on 3 July 2015.

For the 36 month period up to and including June 2016, post-mortems were undertaken 14 of the 16 neonatal deaths reported, with 11 of these being a Home Office post-mortem.

3.4 National Neonatal Audit Programme (NNAP)

BadgerNet enables the Trust's real-time data (along with data from all neonatal units) to be analysed by the National Neonatal Research Database (NNRD) held at the Neonatal Data Analysis Unit (NDAU) in Oxford. NHS England and National Neonatal Audit Programme (NNAP) extract the data for their annual reports and dashboards etc.

The most recent NNAP report was published in November 2015 and captured data from 1 January – 31 December 2014 (see Appendix 4). Results from 10 audit questions are presented in the report. 515 babies and 538 care episodes from Chester NNU were included. Data entry was 100% complete. The specialty identified 2 actions from this report to be achieved by August 2016:

- Ensure good practice for central line (UVC, UAC and peripheral long lines) insertion. Continuing work with catheter care bundle.
- Continue to strive to improve support for parents wishing to breast feed their babies on NNU

The draft 2015 Quarter 2 NNAP data summary (1 January – 30 June 2015) was submitted to the Trust in October 2015 which demonstrated 0 central line infections and an increase from 56% to 64% of babies receiving Mother's milk (exclusively or as part of their feeding).

3.5 Risk Register

The departmental risk register contains 15 risks, the oldest risk listed dates from November 2014. There are 4 risks scored as 'high/red' – these include a pseudomonas risk, availability of neonatal network transfer team and 2 risks associated with the availability of medical staff due to gaps in the junior doctors rotation.

3.6 Staffing

The Neonatal Unit Ward Manager has stated that there have been no warnings to staff regarding capability (performance) or conduct (disciplinary).

ESR data for nursing staff on the Neonatal Unit shows compliance with training as follows:

Training	Compliance %
Individual Competencies	71.1%
Induction	50% (n=2)
Mandatory Training	100%
Appraisal	100%

Source: ESR June 2016

The Department of Medical Education have stated that they are unaware of any concerns regarding capability (performance) or conduct (disciplinary) for doctors in training. The specialty college tutor has confirmed that there have been no significant performance concerns with any of the doctors in training over the period April 2014 to date.

With regard to substantive medical staff within the Neonatal Unit, ESR identifies 7 Consultant Paediatricians and 4 Community Paediatricians. The ESR data for these staff regarding compliance with training and appraisal has been requested.

The Neonatal Unit began inputting nurse staffing and cot occupancy in BadgerNet in October 2014. The BadgerNet data for June 2015 – March 2016 has been utilised to assess compliance with the British Association of Perinatal Medicine (BAPM) standards i.e. 1:1 intensive care, 1:2 high dependency care and 1:4 special care. This review has identified that the Neonatal Unit nurse staffing numbers were below the BAPM recommendations (based upon neonatal acuity) at the time of 7 of the neonatal deaths (out of 11 deaths reported June 2015 – March 2016). BadgetNet has calculated the variation from the BAPM standards for these individual shifts as (minus) -0.6 to (minus)

-2.6 from the recommended nursing establishment. Following on from this, BadgerNet demonstrates lower than recommended provision of 'Qualified in Specialty' (QIS) nurses. 11 incidents were reported by Neonatal Unit staff during the same period (for June 2015 – March 2016) regarding staffing/acuity concerns. 5 (45%) were in November 2015 and 4 (36%) in December 2015.

Staff reported an incident on 18/02/16 confirming that the Neonatal Unit had to close to admissions due to acuity; neonate CC I&S died the same day.

4.0 Findings

Significance of change in mortality levels

There has been a step change in mortality levels in the Neonatal Unit since June 2015. The monthly average numbers and the frequency of mortality over time have increased.

Fluctuation due to common cause variation cannot account for the increased mortality seen in the Neonatal Unit.

Activity as a contributory factor

The number of admissions to the Neonatal Unit is recorded as higher than average for some months during 2015/16; the monthly 'total care days' also shows a sustained period of above average during this period.

Similar periods of increased activity recorded in previous years have not been associated with an increased mortality. Therefore activity levels alone cannot account for the increase but may be a contributory factor.

Acuity as a contributory factor

There is evidence of increased acuity within the second half of 2015 with high acuity 'care days' for both intensive care and high dependency care demonstrating a sustained run of above the average monthly figures over the period.

A sustained increase in low birth weight admissions (<2000g) also corresponded with the increase in mortality levels.

There were no notable trends in prematurity the second half of 2015, with the exception of a small increase in the rate of admissions at 31-36/40 gestation.

Therefore an increased and sustained acuity level may be a contributory factor.

Nurse Staffing Levels as a contributory factor

There is evidence that the Neonatal Unit does not consistently meet the BAPM recommended nurse staffing levels or the recommended provision of 'Qualified in Specialty' nurses.

5.0 Recommendations

The Executive Team is asked to note the challenges to the analysis undertaken and the findings of this mortality review.

Alison Kelly, Director of Nursing & Quality

Ruth Millward, Head of Risk & Patient Safety

July 2016

Appendix 1: Mortality Case Review of 3 Neonates July 2015

Summary of cases

1. Child A

31^{+2} twin 2 1660g born PD June, died 8th June 2015

I&S CVA aged 22, 5 years ago.

Born after CS and was bradycardic. Required 3 sets of inflations breaths before heart rate improved. Stabilised easily on NNU and receiving CPAP, iv antibiotics and iv fluids. UVC inserted but tip was noted to be in left lobe of liver. Peripheral long line inserted. Sudden respiratory arrest and subsequent cardiac arrest at PD of age. Did not respond to resuscitation.

Twin 1 had a respiratory arrest 24 hrs later but responded to resuscitation. Case discussed with specialists in Liverpool and a number of blood investigations undertaken. Management recommended for Twin 1 no different to twin 2.

Awaiting full PM report. Preliminary report did not identify any macroscopic abnormalities. UVC in liver but no significant clots present and no perforation.

2. Child C

30^{+1} 800g born PD June, died 14th June

Severe IUGR and absent end diastolic flow. Oligohydramnios.

Initial brief period of mechanical ventilation and surfactant given. Initial raised lactate and other blood markers of infection. Iv antibiotics and TPN started shortly after birth. Never opened bowels. Distended small bowel on AXR and bile stained aspirates. Received fluid boluses for poor perfusion but unable to gain arterial access for invasive BP monitoring. Poor perfusion and respiratory arrest on 13th June followed by asystole. CPR discontinued after 30min.

Awaiting PM but likely diagnosis of acute bowel obstruction and/or sepsis with background of extreme prematurity and IUGR.

3. Child D

37^{+1} 3130g born PD June, died 22nd June

Prolonged rupture of membranes. Floppy and apnoeic at 12 min of age but responded to inflation breaths. Admitted to NNU at 3.5 hrs of age with poor perfusion and sats. Iv antibiotics, iv fluid bolus and nCPAP given. Received mechanical ventilation overnight and respiratory status improved. However cardiovascularly unstable with blood markers for infection. Acute episode of poor perfusion prior to respiratory arrest and asystole. 25 min CPR and asystole protocol prior to death.

Awaiting PM but most likely diagnosis overwhelming early neonatal sepsis following PROM.

Learning from these cases

There was notable excellence in practice and record keeping in all three cases. Although, the following points are unlikely to have influenced the outcome, the following points for discussion and improvement in practice were noted:

1. No record of capnograph use following intubation. However, doctor recorded see ETT pass clearly through cords and good chest movement verified by consultant.
   ETT left in for PM – no comment that it was incorrectly placed on preliminary PM report.
   Delay in debrief.

2. Delayed cord clamping in preterm babies not hospital policy yet.
   Mask CPAP – no recorded use in Delivery room.
   Small delay in antibiotics and PN starting.
   Difficulties with arterial access.
   Delay in glucose monitoring.
   NGT not in place during AXR.
   Iv ranitidine use for bile stained aspirates.
   Possible need for further discussion with tertiary centre after initial contact.
   Second AXR possibly indicated.
   Time not recorded on one entry.

3. Possible indication for admission to NNU after floppy episode at 12 min of age.
   Possible indication for admission to NNU at 1 hour of age due to hypothermia and grunting.
   Cardiovascular instability at time of extubation.
   Antibiotics: Cefotaxime added and BenPen changed to 8 hourly. Gentamicin might have been given early.

COCH Neonatal Mortality (Deaths in NNU >24/40)

2008	2009	2010	2011	2012	2013	2014
4	1	1	3	3	2	3

COCH 2015:

11% of network admissions (192 of 1714)

13% of deaths (3 of 23)

Network Annual Report

Neonatal network: Cheshire & Merseyside Date range: Custom From 01 Jan 15 to 30 Jun 15 Edit

Unit	Total Admissions	Total Babies	Inborn	FirstEpisodes	% Inborn
Arrowe Park, Wirral	184	180	164	166	91.11
Countess of Chester	192	189	183	183	96.83
Leighton	197	180	173	173	96.11
Liverpool Womens	570	553	473	516	85.53

Unit	Total Admissions	Total Babies	Inborn	FirstEpisodes	% Inborn
Macclesfield District General	54	50	42	42	84
Ormskirk	173	163	161	162	98.77
Warrington and Halton Hospitals NHS foundation Trust	206	198	192	195	96.97
Whiston	138	131	124	126	94.66
Total	1714	1644	1512	1563	

Network Annual Report - Outcomes - Gestation

Gest	Inborn	InbornDeaths	Outborn	OutbornDeaths	SubsEpsBabies	SubsEpsDeaths	Total Babies	TotalDeaths	SurvivalPercentage
22	1	0	0	0	0	0	1	0	100.0
23	3	1	0	0	0	0	3	1	66.7
24	5	3	0	0	8	1	13	4	69.2
25	12	2	0	0	5	0	17	2	88.2

Gest	Inborn	InbornDeaths	Outborn	OutbornDeaths	SubsEpsBabies	SubsEpsDeaths	Total Babies	TotalDeaths	SurvivalPercentage
26	14	2	0	0	4	0	18	2	88.9
27	15	1	1	0	3	1	19	2	89.5
28	33	3	0	0	1	0	34	3	91.2
29	20	0	2	0	1	0	23	0	100.0
30	35	1	0	0	2	0	37	1	97.3
31	45	1	0	0	3	0	48	1	97.9
32	56	0	0	0	4	0	60	0	100.0
33-36	523	3	3	0	7	0	533	3	99.4
37-42	693	4	5	0	3	0	701	4	99.4
Unknown	57	0	40	0	0	0	97	0	100.0

S Brearey

1st July 2015

Appendix 2: Comprehensive Case Review of 10 Neonates February 2016

Thematic Review of Neonatal Mortality 2015 – Jan 2016

Contents

8th Feb 2016

Attendees:

S Brearey	Neonatal lead
Doctor V	Consultant
N Subhedar	LWH consultant
E Powell	NNU manager

A Murphy	Lead nurse Children's services
L Eagles	NNU nurse
D Peacock	Quality improvement facilitator

Apologies:

C Green	Pharmacy

Purpose of Meeting:

There was a higher than expected mortality rate on NNU in 2015. Cases have been reviewed at NNIRG, perinatal mortality review or neonatal review meetings and action plans have been made (See **Appendix 1**). An obstetric thematic review did not identify any common themes or identifiers that might be responsible for the rise in mortality in 2015. The aim of the neonatal meeting was to review the cases again as a multidisciplinary team with an external reviewer and tertiary level neonatologist to assess:

- Were all action points completed
- Any new areas of care improvement
- Any possible common themes
- Discuss if further action is required

Patient electronic record, written notes, radiology images and Meditech entries in addition to previous reviews were available.

It was noted by NS that there was a clear and strong governance culture in CoCH which was evident at the meeting and that the number of PMs undertaken was impressive and indicated a willingness to learn and improve.

Summary of mortality cases discussed

Case:	Date of death:	Diagnosis and summary of discussion:	Actions:	Date complete:
CC I&S	5th Apr 2015	**Severe HIE**. Baby transferred to Arrowe Park for continued cooling but died there on day PD. Obstetric review identified some areas of care improvement. PMM agreed neonatal care before transfer was appropriate and timely. 2015 audit of HIE identified excellent neonatal care in the 4 cases of HIE and good outcomes in 3 cases. CoCH actively cool babies prior to transfer.	Nil	
CC **Child A**	8th Jun 2015	**Coroner's PM: Unascertained** **I&S** aged 22. Twin born at 31 weeks gestation initially in good condition. UVC inserted and lying in left lobe of liver. Peripheral long line inserted with a view to remove UVC once long line in situ. Long line reported later as projected over the junction of the innominate vein and SVC which is satisfactory position. Registrar that evening felt it required withdrawing a little. Sudden unexpected arrest aged **PD**. Twin also arrested 24 hrs later. Delay in staff debrief. No PM evidence of line or UVC related complication. Crossed pulmonary arteries on PM. Agreement today that line related complication very unlikely to have caused arrest.	Inquest 23rd March 16	
CC **Child C**	14th Jun 2015	**PM:** **1a. Widespread hypoxic ischaemic damage to heart** **1b. Immaturity of lung** **1c. Severe maternal vascular under perfusion** 30 week gestation severe IUGR, AEDF and oligohydramnios. Delayed cord clamping. Brief period of ventilation. UVC displaced on handling. Raised lactate and infection markers. Never opened bowels and bile stained aspirates. Respiratory arrest on day PD Agreed PM report but no cause for deterioration identified.	Delayed cord clamping policy confirm with staff. UVC fixation policy	

			Ranitidine in preterm babies – revise guidance based on evidence. Hyperglycaemia policy.	
CC Child D	22nd Jun 2015	**PM: 1A: Pneumonia with acute lung injury** PROM from 36^{+6} but delivery at 37 weeks. No antibiotics given before delivery. Dusky episode at 12 min of age probably should have led to admission to NNU. Admitted at 3.5 hrs of age in poor condition but then treated appropriately and improved, being extubated the following day. Arrest and deterioration on day PD Group felt initial delay in starting antibiotics very unlikely to be contributory to death. Uncertain of cause for deterioration after initial improvement. UVC was withdrawn to a "low" position contrary to draft BAPM guidance. Current guideline (CoCH or LWH) does not specify acceptable position for UVC. Pulse oximetry as part of NEWS chart might help staff detect unwell babies earlier.	Continuing to emphasise to trainee doctors importance of following early sepsis guideline at inductions and teaching. Revise UVC guideline re position T8-9. Discussion with midwifery team re introduction of pulse oximetry in NEWS charts.	
CC Child E	4th Aug 2015	**1a) Necrotising enterocolitis** **b) Prematurity (No PM)** 29^{+5} gestation twin 1327g. Delayed cord clamping. Signs of maladaptation (high glucose, bile stained aspirates). Large amount of blood (12ml) from NGT prior to arrest despite clotting being only mildly deranged. Teicoplanin not started with Cefotaxime as per guideline. AXR some time before arrest showed no obvious evidence for NEC. No major haemorrhage policy for neonates currently but not in LWH either or any national guidance.	Delayed cord clamping policy confirm with staff. Ranitidine in preterm babies – revise guidance based on evidence.	
CC I&S	4th Sep 2015	**PM:** **1a) Ebstein anomaly with recurrent supraventricular tachycardia and cardiac failure** **b) Peripartem asphyxia with metabolic acidosis** Term baby with meconium at delivery and HR 260 (SVT) for 3 hours before resolving spontaneously. CXR normal heart size. 12 lead ECG normal, UAC monitoring normal BP. Occasional brief episodes of SVT in day 1 and 2 despite establishing feeds well. Day PD possible seizure and screened for infection. Bradycardic arrest and unsuccessful resuscitation. BC grew alpha haemolytic strep in <24 hrs – possibly contributory. Murmur detected on day 2 along with SVT might have indicated a cardiology opinion but would not have changed management.		

		Consultant written to parents to discuss but no reply – might have moved I&S		
CC I&S	27th Sep 2015	**PM:** **1a) Severe multiple congenital anomalies (oral facial digital/OFD Syndrome type 6/Varadi syndrome)** Birth abnormalities noted included Cleft lip and palate, Polydactyly, Low set ears, Short arms, Heart murmur and Micro-penis. Poor respiratory effort shortly after birth. Intubated but poor chest movement. Arrest at PD of age. Abnormalities of tracheal rings on PM.		
CC Child I	23rd Oct 2015	**Awaiting PM – preliminary report no evidence of NEC** 27 week gestation born at LWH. Multiple transfers between LWH, COCH and APH. Treated conservatively for NEC. Arrests on 13th, 14th and 15th October, rapid improvement after each arrest. Discussion with neonatologist rather than or as well as surgeon would have been appropriate on 13th Oct. Agreed plan with neonatologist from LWH on 14th Oct to stay in CoCH probably inappropriate in retrospect. Decision to transfer to APH rather than LWH on 15th also probably inappropriate as LWH should be considered surgical centre. Awaiting joint meeting with CoCH, LWH and AH surgical colleagues. Already reviewed at network level.	To clarify neonates with surgical or cardiology conditions should be discussed with LWH and transferred there in preference to APH. Network review of case.	
CC I&S	13th Dec 2015	**1a) Prematurity with Sepsis** **b) Maternal rupture of membranes with chorioamnionitis (No PM)** Concealed pregnancy, delivered on day of booking, no antenatal steroids or antibiotics. Maternal CRP 266, baby CRP 245. Foul smelling liquor. Antibiotics started. Extubated at 2 hours of age. Gentamicin frequency changed by consultant to 24 hrs. Following day advice by pharmacist to withhold gentamicin until result and if elevated to delay dose. Advice contrary to guideline and prescription sheet but followed by reg and nurse. Arrest at PD, second dose of gentamicin given at PD. Antibiotics subsequently changed to second line. Delay in transfer of baby to LWH so that she was too unstable to transfer by the time the transport team arrived. Initial estimate for arrival time given was 4 hrs and they arrived after 10.5 hrs. Difficulties in prioritising transfers for transport team. Discussed alternatives such as NEWTS and Manchester team.	To discuss with Microbiology negative results. To discuss with Pharmacy and clinical team re error in advice given by junior pharmacist and not questioned by clinical team. Transport problems reviewed by neonatal network. Alternatives to Cheshire and Merseyside Transport team to be circulated to staff.	

CC I&S	8th Jan 2015	**Awaiting PM – probable prematurity and sepsis** Mum type 2 diabetic, AEDF, twin. 30 weeks gestation 1547g. Delayed cord clamping. Intubated on NNU, curosurf. UVC in a high position – not pulled back. Raised lactate and increasing oxygen requirement and ventilation pressures. CXR review sticker not used. Antibiotics changed on advice from LWH con and then again on advice from APH consultant. Arrest on day PD at similar time to twin brother who was transferred to NICU at APH. Discussed possibility of nCPAP on resuscitaire in delivery room.	Delayed cord clamping policy confirm with staff. Revise UVC guideline re position T8-9. Await PM result. Antibiotic policy discussed at network level. ? align policy with APH.	

Themes identified during discussion of all cases

There was no common theme identified in all the cases. One baby had severe HIE and the Trust's rate of HIE in 2015 was low and similar to previous years. One baby had severe multiple congenital abnormalities with a very poor prognosis. One baby had a significant congenital heart disease and probable sepsis. 2 babies (possibly 3 pending PM result) died of sepsis despite timely antibiotic treatment. 2 babies (possibly 3 depending on PM result) the cause of death is uncertain despite having PMs. Themes identified in more than one baby reviewed included:

1. **Sudden deterioration**
   Some of the babies suddenly and unexpectedly deteriorated and there was no clear cause for the deterioration/death identified at PM.

2. **Timing of arrests**
   6 babies (from 9 deaths reviewed) had arrests between 0000 – 0400.

   Action: SB and EP to review all these cases focusing on nursing observations in the 4 hours before the arrests. Aim to identify if unwell babies could have been identified earlier. Identify any medical or nursing staff association with these cases.

3. **Delayed cord clamping in preterm deliveries**
   3 babies had delayed cord clamping when hospital guidance says this is only for term babies. There is national recommendations and evidence to support delayed cord clamping in preterm babies but the obstetric, midwifery and paediatric teams have not yet been able to ensure adequate temperature control for all preterm babies close to Mum during delayed cord clamping. Hypothermia is associated with increased neonatal preterm mortality However, there were no cases of severe hypothermia and only one case of mild hypothermia in the cases reviewed.

   Actions: **Teams have already agreed and disseminated current policy**

   Multidisciplinary work to enable safe delayed cord clamping in preterm babies

4. **Ranitidine in preterm babies**

NS advised group of increased risk of death in preterm babies given ranitidine. 2 babies in CoCH were given ranitidine. It is still in common usage in most neonatal units and CoCH are unlikely to be an outlier in its use.

Action: **NS to send paper re risk of ranitidine in preterm babies. Practice change based on this evidence.**

5. **UVCs in preterm babies**
   3 babies had care issues around UVCs. One was used when too low, one was used when too high and one was displaced and came out. NHS England has recently reviewed UVC incidents and BAPM has recently published draft guidance. CoCH guidance could be improved by revising guidance to include correct position and standardising fixation.

   Action: Revise UVC guidance once BAPM draft guideline finalised

Other suggestions for improving practice

1. **CESDI grading system**
   Introduce CESDI grading system for all future mortality reviews as already used in network mortality meetings.

2. **Resuscitation drugs proforma**
   Staff have highlighted difficulties recording rescusitation drug administration now that electronic prescribing is used. A draft sheet to record resuscitation drugs has been proposed and will be shared with neonatal network.

3. **Simulation training**
   Simulation training is becoming more popular in many neonatal units with use of sim babies and sim centres. The paediatric department should look to start simulation training for nursing and medical staff on a regular basis. This will need investment in equipment and training of trainers.

4. **HERO score on NNU**
   HERO score calculates a measure for heart rate variability which is displayed on monitors and can be used to assist clinical staff in predicting clinical deterioration. Some evidence that its use reduces mortality

Summary Action Plan

Outstanding Action	Lead	Update	Completion Date
Delayed cord clamping policy: Confirm with staff that this is not current hospital policy for preterm babies.	Brearey Brigham Grimes	Completed All staff informed	Feb 2016
Revise UVC guideline to include standardised fixation policy and specification for T8/T9 optimal position as per BAPM draft guidance	Brearey Farmer	Awaiting ratification of BAPM draft guidance before revision of CoCH policy.	Dec 2016
Ranitidine in preterm babies – revise guidance based on evidence.	Brearey	All consultant paediatricians informed of evidence of risk. Department to discuss best way to alert prescribers to potential risk. SB to share with neonatal network	Completed. April 2016
Complete a neonatal hyperglycaemia policy	Brearey	To appoint a trainee doctor with this task in March 2016	Sep 2016
Continuing to emphasise to trainee doctors of the importance of following early sepsis guideline at inductions and teaching.	Brearey Doctor ZA		Ongoing
Discussion with midwifery team re introduction of pulse oximetry in NEWS charts.	Brearey Grimes		Dec 2016
Network to discuss case CC Child I of multiple transfers	Subhedar	Table top meeting took place on 26th Feb – awaiting report	

between hospitals			
To discuss with Microbiology re CC I&S why all micro samples were negative.	Brearey		April 2016
Discussion regarding Pharmacist cover on NNU as inappropriate advice given	Green Brearey		April 2016
Transport problems reviewed by neonatal network. Alternatives to Cheshire and Merseyside Transport team to be circulated to staff.	Powell	Staff notified and poster on NNU with process	Complete
Antibiotic policy discussed at network level. ? Align policy with APH.	Brearey Webster		Dec 2016
SB and EP to review all these cases focusing on nursing observations in the 4 hours before the arrests. Aim to identify if unwell babies could have been identified earlier. Identify any medical or nursing staff association with these cases.	Brearey Powell	Only one case identified possible delay in starting second line antibiotics earlier based on nursing observations. 1 Action below has come from this review	Complete Observations prior to collapse review.docx
Every A4 section of obs charts should have patient details, a date and time – to assist reviewing scanned Evolve records.	Powell Farmer		Dec 2016
Introduce CESDI grading system for all future mortality reviews as already used in network mortality meetings.	Brearey		April 2016
Develop a resuscitation drugs proforma to assist with record keeping during resuscitations.	Brearey	Second draft completed and under review	
Develop a neonatal simulation training programme	Doctor V Farmer		March 2017
Consider adopting Hero score on NNU monitors	Brearey		March 2017

S Brearey

2nd March 2016

APPENDIX 1: Neonatal Mortality January 2015-January 2016

NEONATAL MANAGER: Eirian Lloyd Powell

Baby's name	DOB	Gest	Review	Reason for admission	DOD & AGE	Cause of death	Staff allocated	Staff on duty
I&S CC I&S Con: RJ	PD/03/15 14.02hrs	40/40	Level 2 Report  I&S.doc	HIE	05/04/15 (PD)	Severe HIE	Transferred to APH on day 1	NA
Child A Con: MS Resus: RJ	PD/06/15 20.31hrs	31/40	 PERINATAL MORBIDITY AND MOI	PREM	08/06/15 21.00hrs (PD)	Maternal I&S	Care handed to Lucy Letby at 20.00hrs	Caroline Bennion(RN) **Nurse T** Mary Griffith (RN) Lisa Walker (NN) Liz Marshall (NN)

Baby's name	DOB	Gest	Review	Reason for admission	DOD & AGE	Cause of death	Staff allocated	Staff on duty
Child C Con: MS Resus JG	PD/06/15 15.31hrs	30/40	NEONATAL MORTALITY MEETING OSR: Child C doc	PREM IUGR AEDF	14/06/15 05.58hrs PD	PM: 1a. Widespread hypoxic ischaemic damage to heart 1b. Immaturity of lung 1c. Severe maternal vascular underperfusion	Sophie Ellis initially and handed over to Melanie Taylor	Nurse W (RN) Mel Taylor (RN) Lucy Letby (RN) Nicky Dennison (NN) Liz Marshall (NN)
Child D Con EN Resus EN	PD/06/15 16.01hrs	37/40	Child D draft addendum.doc	Dusky episode in labour ward	22/06/15 04.25hrs (PD)	PM: 1A: Pneumonia with acute lung injury.	Caroline Oakley	Nurse X (RN) Lucy Letby Kate Ward Liz Marshall

Baby's name	DOB	Gest	Review	Reason for admission	DOD & AGE	Cause of death	Staff allocated	Staff on duty
Child E Con: JG Resus Doctor ZA	PD/07/15 17.53hrs	29/40	Child E Review SB.docx	PREM REDF	04/08/15 01.40hrs (PD)	NEC	Lucy Letby	Shelley Tomlins (RN) Caroline Oakley (RN) Belinda Simcock(RN) Lisa Walker (NN) Val Thomas (NN)
I&S **PD** Con: SB Resus MS	PD/09/15 08.15hrs	40/40	I&S Review SB.docx OSR: I&S doc	SVT	04/09/15 05.16hrs (PD)	Ebstein's anomaly Alpha haemolytic strep infection	**Nurse X**	Mel Taylor (RN) Lucy Letby (RN) Ashleigh Hudson(RN) Jenny Jones (NN) Val Thomas (NN)

Baby's name	DOB	Gest	Review	Reason for admission	DOD & AGE	Cause of death	Staff allocated	Staff on duty
I&S PD Con: JG Resus: MS	PD/09/15 04.38hrs	39/40	I&S Review SB.docx OSR: I&S.doc	Congenital Abnormalities	27/09/15 08.52hrs (PD)	Multiple congenital abnormalities PM: Orofacial digital syndrome type 6 (Varadi Papp syndrome)	Laura Eagles	Kate Ward (RN) Ashleigh Hudson (RN) Kate Bissell (RN) Liz Marshall (NN) Night staff Chris Booth (RN) Shelley Tomlins (RN) Nurse W (RN) Lucy Letby (RN)
Child I Con Doctor V Resus: JG	PD/08/15	27/40	Child I Review SB.docx NEONATAL MORTALITY MEETING	PREM	23/10/15 0230hrs (PD)	Awaiting PM 6 admissions Lwh/Aph/Coch	Ashleigh Hudson	Chris Booth (RN) Mel Taylor (RN) Lucy Letby (RN) Val Thomas (NN)
I&S I&S Con: Doctor ZA Resus: Doctor V	PD12/15 15.25hrs	28/40	I&S Review SB, EP&DP I&S.do	PREM	13/12/15 05.30hrs (PD)	?sepsis High CRP/neuts/WCC Gent issue (omitted on pharmacy advice – incorrect information)	Kate Ward	Nurse W Lucy Letby

Baby's name	DOB	Gest	Review	Reason for admission	DOD & AGE	Cause of death	Staff allocated	Staff on duty
I&S PD Con: EN Resus: EN	PD/01/15 18.58hrs	30/40	I&S Review SB.docx OSR: I&S doc	PREM Brother has been transferred to APH	08/01/15 16.15hrs PD	?sepsis	Lucy Letby (days) Caroline Bennion (nights)	Caroline Oakley (caring from twin 2) Nurse Z Yvonne Farmer Laura Eagles

Appendix 3: Nursing review of the health record, vital signs monitoring, feeding charts and blood gas results of 10 Neonates March 2016

Baby's name	Time and date of death (day of life)	Review of case notes, obs charts, feed charts and blood gas results prior to arrest	Learning

Baby's name	Time and date of death (day of life)	Review of case notes, obs charts, feed charts and blood gas results prior to arrest	Learning
I&S PD Con: RJ	5th Apr 15 (PD)	Immediate transfer to APH shortly after birth. Died in APH.	NA
Child A Con: MS Resus: RJ	8th Jun 15, 2100 (PD)	Nursing obs chart showed persistent tachypnoea (60-80/min) in PD before arrest. However, saturations were 95-100% in air on CPAP. Cap gases at 0013, 0637 and 1413 normal other than mildly raised and stable lactate (1.6, 2.6, 2.7)	Satisfactory record of nursing observations, blood gases and medical and nursing entries.
Child C Con: MS Reg: K Davies Resus JG Nurse: Taylor, Ellis	14th Jun 15, 0558 (PD)	13th Jun: CRP increased. On CPAP, then optiflow 23% FiO2. All observations stable and normal range. NGT aspirates black/bile stained. Plan for repeat AXR if worsens and iv ranitidine. 1800 gas normal, no further cap gases. However, no indication to repeat gases based on obs chart record. 2300 sudden collapse	AXR was not repeated despite continued dark aspirates. Lack of variability in observations might have been an indicator for pathology. Hero score might have been useful.

Baby's name	Time and date of death (day of life)	Review of case notes, obs charts, feed charts and blood gas results prior to arrest	Learning
Child D Con EN Resus EN Reg: Brunton Nurse: Oakley	22nd Jun 15, 0425 (PD)	21st Jun 1900: Rising lactate, slight delayed cap refil, feet purple and bruised, some desats, irreg resp effort. 2110: Hyponatraemia. No resp distress. No abnormal gases. 0140: Discoloration, collapse and arrest	Satisfactory record of nursing observations, blood gases and medical and nursing entries. Frequent medical reviews and appropriate actions.
Child E Con: JG Resus: Doctor ZA Reg: Harkness Nurse: Nurse W	4th Aug 15, 0140 (PD)	3rd Aug 2210: GI bleed 2221: gas pH 7.22, pCO2 8.81 2300: GI bleed 13ml – iv ranitidine and metronidazole, discussed with consultant – iv fluid bolus. Nursing observation chart satisfactory. Decision for elective intubation. 2340: Sudden collapse bradycardia desaturation and emergency intubation.	Satisfactory record of nursing observations, blood gases and medical and nursing entries. Appropriate actions after deterioration noted. ?Delay in elective intubation between 2300 and 2340, when baby collapsed.

Baby's name	Time and date of death (day of life)	Review of case notes, obs charts, feed charts and blood gas results prior to arrest	Learning
I&S I&S Con: SB Resus MS Reg: Ventress Nurse: Nurse X	4th Sep 15, 0516 (PD)	3rd Sep 1000: New murmur heard. ECG normal axis, no gross abnormalities. Decision to review mane and scan if persistent. Baby SVIA and tolerating NGT feeds. 1945: All obs satisfactory, tolerating 3 hrly bottles. 2005: 4 min self-resolving SVT. All other obs normal. 2315: brief desat requiring oxygen. Between 2000-0100 observations did change: increased RR, reduced temp, bradycardia. 0115: Profound desaturation, rigid, cycling arm and leg. Metabolic acidosis. Fluid bolus given , iv antibiotics, screened for infection.	?Possibility of screening earlier and starting second line antibiotics. PM: Ebstein's anomaly and alpha haemolytic strep infection
I&S PD Con: JG Resus: MS	27th Sep 15 0852 (PD)	Multiple congenital abnormalities PM: Orofacial digital syndrome type 6 (Varadi Papp syndrome) Compromised from birth.	
Child I Con: Doctor V Resus: JG Reg: Chang Nurse: Hudson	23rd Oct 15 0230 (PD)	22nd Oct 1100 – 2300: all nursing observations satisfactory. Sudden unexpected collapse at 2400.	Every A4 section of obs charts should have patient details, a date and time – to assist reviewing scanned Evolve records.

Baby's name	Time and date of death (day of life)	Review of case notes, obs charts, feed charts and blood gas results prior to arrest	Learning
I&S PD Con: Doctor ZA Resus: Doctor V Reg: Neame Nurse: Ward	13th Dec 15 0530 (PD)	Between 2227-0334 5 gases showed high CO2, and lactates. Transport team in attendance and trying to stabilise baby for transfer.	Satisfactory record of nursing observations, blood gases and medical and nursing entries. Appropriate actions after deterioration noted.
I&S Twin 1 PD Con: EN Resus: EN Reg: Harkness Nurse: Benion	8th Jan 16, 1555 (Collapse at approx. 0800)	0200 review by reg for increased oxygen requirement (21% to 58%) on vent. ETT pulled back 0.5cm and morphine increased – improved chest movement. Vent rate increased over rest of evening 30 to 50/min. No other entry from Reg until 0855 when baby had profound desat and bradycardia. Twin was sick as well at same time and also requiring intensive care.	Observations and increased O2 requirement acted on appropriately over evening. In retrospect: Second line antibiotics might have been started between 0000-0800. Would have been better practice to record further reg reviews of response to interventions.

S Brearey, E Powell

2nd March 2016