Imperial College London

NDAU
Neonatal Data Analysis Unit

Brain injury occurring during or soon after birth: annual incidence and rates of brain injuries to monitor progress against the national maternity ambition.

2016 and 2017 data

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1 Context

In November 2015, the Secretary of State for Health announced a national ambition to halve the annual rates of stillbirth, neonatal death, maternal death and brain injuries occurring during or soon after birth in England.

The Department of Health recognised that there was a lack of consensus in relation to the definition of *brain injury occurring during or soon after birth,* and limited data sources for measuring such brain injuries. Therefore the Department of Health commissioned a piece of work to define *brain injury occurring during or soon after birth*, and using the National Neonatal Research Database (NNRD) established a baseline for 2010 and caculated annual rates up to 2015. These data have been previously published[1] [2].

The Department of Health and Social Care want to build on this previous work, specifically to track progress towards the National Maternity Ambition to halve the rate of *brain injuries occurring during or soon after birth* by 2025, with a 20% reduction by 2020[3].

In this follow-up report we provide the following rates for 2016 and 2017 in England:

(a) Annual rates of *brain injuries occurring during or soon after birth* for all gestational ages, and for term and preterm infants separately.
(b) Annual rates of individual conditions that contribute to *brain injuries occurring during or soon after birth.*

In addition we provide the following annual regional rates at the level of maternity and neonatal providers:

(c) Annual rates of *brain injuries occurring during or soon after birth* by Sustainability and Transformation Partnerships (STP) with cases attributed by *mother's postcode of residence at birth*.
(d) Annual rates of *brain injuries occurring during or soon after birth* by Neonatal Operational Delivery Network (ODN) with cases attributed by *place of birth.*

[1] Brain injury occurring during or soon after birth: a report for the national maternity ambition commissioned by the Department of Health
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/662974/Report_on_brain_injury_occurring_during_or_soon_after_birth.pdf
[2] Gale C, Statnikov Y, Jawad S On behalf of the Brain Injuries expert working group, et al., Neonatal brain injuries in England: population-based incidence derived from routinely recorded clinical data held in the National Neonatal Research Database. *Archives of Disease in Childhood - Fetal and Neonatal Edition*
https://fn.bmj.com/content/early/2017/10/22/archdischild-2017-313707
[3] Safer maternity care: progress and next steps. Department of Health, November 2017
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/662969/Safer_maternity_care_-_progress_and_next_steps.pdf

2 Methods

2.1 Defining brain injuries occurring during or soon after birth

The definition for *brain injuries occurring during or soon after birth* for the national maternity ambition was agreed by an expert group as previously described[4]. This definition is as follows:

- **Population:** ***all babies admitted to a neonatal unit in England***
- **Time period after birth:** ***all brain injuries that are detected during the neonatal unit stay***
- **Conditions to be included:**
    a. *Infants with a diagnosis consistent with* ***hypoxic ischaemic encephalopathy****: term and near-term infants only*
    b. *Infants with a diagnosis of* ***intracranial haemorrhage****,* ***perinatal stroke****,* ***hypoxic ischaemic encephalopathy (HIE), central nervous system infection, and kernicterus (bilirubin encephalopathy)****: all infants*
    c. ***preterm white matter disease (periventricular leukomalacia)****: preterm infants only*
    d. *Infants with a recorded* ***seizure****: all infants*
- **Denominator:** ***all live births in England*** *to be used* as the denominator for calculating the annual rate of "brain injuries occurring during or soon after birth"
- **Exclusions:** a consensus decision[4] was made to present data before and after exclusion of infants with the following conditions leading to brain injury prior to birth: ***congenital encephalopathies (including inborn errors of metabolism), congenital infections and congenital brain abnormalities***

Further descriptive information and the NNRD data fields used to determine *brain injuries occurring during or soon after birth* and exclusions are shown in Appendix 1.

[4] Brain injury occurring during or soon after birth: a report for the national maternity ambition commissioned by the Department of Health
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/662974/Report_on_brain_injury_occurring_during_or_soon_after_birth.pdf

2.2 Regional attribution of cases of brain injuries occurring during or soon after birth

The Department of Health and Social Care commissioned the Neonatal Data Analysis Unit to provide regional rates of *brain injuries occurring during or soon after birth* by maternity and neonatal providers. Regional rates of *brain injuries occurring during or soon after birth* are reported at the organisational level of Neonatal Operational Delivery Network (ODN) or Local Maternity System (LMS) of birth, in contrast to regional rates of neonatal deaths and stillbirths which have been reported at Trust level. This is because some neonatal conditions that comprise *brain injuries occurring during or soon after birth*, such as cystic periventricular leukomalacia, cannot be attributed accurately to an individual neonatal or maternity unit because there is a variable and unpredictable time delay between injury and clinical detection, or because the final injury may be the end result of multiple factors occurring at different time points and locations. Therefore in a networked model of care where postnatal transfers are common, it is not possible to attribute brain injuries accurately to an individual Trust nor appropriate to do so.

The regional organisation of maternity and neonatal services in England are not aligned. Maternity services are organised as Local Maternity Systems (LMS) covering populations of 500,000 to 1.5 million, within which all providers work to common agreed standards and protocols[5]. LMS boundaries are coterminous with Sustainability and Transformation Partnerships (STP)[6], of which there were 44 in 2016 and 2017[7]. In early 2019 Northumberland, Tyne and Wear and North Durham STP; Durham, Darlington, Teesside, Hambleton, Richmondshire and Whitby STP; and West, North and East Cumbria STP merged to form the Cumbria and North East STP; this has led to a reduction in STP in England to 42. As directed by the Department of Health and Social Care, this report provides rates of brain injuries aligned with the most recent grouping of 42 STP.

Neonatal services are organised as regional Neonatal Operational Delivery Networks (ODN). Neonatal Operational Delivery Networks are focussed on coordinating patient pathways between providers over a wide area to ensure access to specialist resources and expertise; babies that requires neonatal care should receive all such care within their local Neonatal ODN. Neonatal ODN do not align with LMS. There are 11 Neonatal ODN[8]:

- East Midlands ODN (formerly Central Newborn Network & Trent Perinatal Network)

[5] The National Maternity Review, NHS England, 2017, https://www.england.nhs.uk/wp-content/uploads/2016/02/national-maternity-review-report.pdf
[6] Implementing Better Births: A resource pack for Local Maternity Systems, NHS England, 2017; https://www.england.nhs.uk/wp-content/uploads/2017/03/nhs-guidance-maternity-services-v1.pdf
[7] NHS England, last accessed 18th March 2019. https://www.england.nhs.uk/integratedcare/stps/view-stps/
[8] East Midlands ODN, last accessed 18th March 2019. https://www.emnodn.nhs.uk/about-us/what-is-a-neonatal-network/

- East of England ODN
- London ODN (which comprises three clinical networks: South London, North West London and North Central & East London)
- North West ODN
- Northern ODN
- South East Coast ODN
- South West ODN
- Southern West Midlands ODN
- Staffordshire, Shropshire and the Black Country ODN
- Thames Valley and Wessex ODN
- Yorkshire and Humber ODN

In March 2018, a number of NHS Trusts were reassigned to different ODN. Specifically, George Eliot Hopsital NHS Trust, South Warwickshire NHS Foundation Trust, and University Hospitals Coventry and Warwickshire NHS Trust moved from the East Midlands ODN to the Southern West Midlands Neonatal; Sandwell and West Birmingham Hospitals NHS Trusts moved from the Southern West Midlands ODN to the Staffordshire, Shropshire and the Black Country ODN. Babies with brain injuries were assigned to an ODN using the assignment of neonatal units/NHS Trusts to ODN as existed prior to March 2018. This was done to ensure that numerator and denominator data aligned, since denominator data were only available for the pre March 2018 organisational structure of neonatal services (as described in section 2.4.3). Thus, this report presents rates of brain injuries by ODN using the assignment of neonatal units/NHS Trusts to ODN as existed prior to March 2018. Data are presented for the 11 Neonatal ODN and data for London are additionally presented by clinical network: North Central & East London, North West London, and South London.

Rates of *brain injuries occurring during or soon after birth* are reported with attribution at the following regional levels; these attributions align with other national data including Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK)[9]:

1. By STP/LMS with attribution of cases based on the postcode of the **mother's residence at the time of delivery**
2. By Neonatal ODN with attribution of cases based on **place of birth**

[9] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018. https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Perinatal%20Surveillance%20Full%20Report%20for%202016%20-%20June%202018.pdf accessed 12th February 2019

2.3 Numerator data source: National Neonatal Research Database

The Department of Health and Social Care commissioned the National Neonatal Research Database (NNRD) as the numerator source for the calculation of rates of *brain injuries occurring during or soon after birth* for the national maternity ambition.

The NNRD is formed from summary electronic patient data entered on all admissions to National Health Service (NHS) neonatal units in England; these data are held as a national resource. Data in the NNRD have undergone processing to identify duplicates, out of range values, internal inconsistencies, and other potentially erroneous entries. In addition to these internal processes, feedback quality assurance checks are undertaken with clinicians for key items as part of the National Neonatal Audit Programme. Data in the NNRD are merged across multiple patient episodes, if necessary for the purposes of an analysis.

All neonatal units (currently 100% of NHS neonatal units in England), that contribute data to the NNRD form the UK Neonatal Collaborative, UKNC. Approximately 400 predefined data items, the Neonatal Data Set[10], are extracted quarterly from these electronic patient records to form the NNRD. The Neonatal Data Set is an approved NHS Information Standard (ISB1595).

2.3.1 National counts of brain injuries

National counts of *brain injuries occurring during or soon after birth* are calculated using a cohort of infants who receive at least one episode of care in a NHS neonatal unit in England. As part of the NNRD data cleaning process, babies with missing gestational age or missing birth year are excluded from the analysis data set. To extract counts for term and preterm babies, gestational ages of ≥37 weeks and <37 weeks respectively were applied.

2.3.2 Regional counts of brain injuries by Sustainability and Transformation Partnerships and Local Maternity Systems

The NNRD holds data on mother's Lower Super Output Area (LSOA) at time of birth, which were used to assign cases to the STP/LMS associated with each LSOA. LSOAs were mapped to STP/LMS using data provided by the Department of Health and Social Care (Appendix 3) using the ONS Geoportal[11]. A number of babies with a definition of *brain injuries occurring during or soon after birth* had missing information for mother's

[10] http://www.datadictionary.nhs.uk/data_dictionary/messages/clinical_data_sets/data_sets/national_neonatal_data_set/national_neonatal_data_set_-_episodic_and_daily_care_fr.asp?shownav=0

[11] ONS Geoportal. Last accessed 22nd Janary 2019. https://geoportal.statistics.gov.uk/datasets/lsoa-2011-to-clinical-commissioning-groups-to-sustainability-and-transformation-partnerships-april-2018-lookup-in-england-version-3

LSOA at time of birth in the NNRD and these babies could not be mapped to a STP/LMS (Table 11).

2.3.3 Regional counts of brain injuries by Neonatal Operational Delivery Networks

The NNRD holds data on neonatal unit of first admission which were used to attribute cases to the appropriate Neonatal ODN using data provided by the Department of Health and Social Care (Appendix 2). This mapping tool combines data from the Royal College of Obstetricians and Gynaecologists (RCOG) organisational survey[12] (which maps neonatal units/sites to NHS Trust) and data from MBRRACE-UK[13] (which maps NHS Trust to ODN) and is congruent with the organisational structure of neonatal ODN prior to March 2018 (see section 2.2 for further detail). Babies born in transit, at home or with missing information for place of birth were assigned to the NHS Trust and appropriate Neonatal ODN by their first provider of neonatal care (neonatal unit of first admission).

For inclusion in the national counts of brain injuries, babies were required to have at least one episode of care in an English NHS neonatal unit. For inclusion in the regional counts by Neonatal ODN babies were required to be born in an English NHS unit. As a result, babies born in Scotland or Wales who had at least one episode of care in an English neonatal unit were excluded from the regional counts of brain injuries by Neonatal ODN, but have been included in the national analysis. In addition, babies born at The Portland Hospital for Women and Children and RAF Lakenheath (48th Medical Group) are excluded from the Neonatal ODN level analysis as these hospitals are not part of a Neonatal ODN, however they are included in the analysis at the national level. The sum of brain injuries across the Neonatal ODN is therefore lower than the total counts of brain injuries from the national analysis (Table 13).

St Richard's Hospital and Worthing Hospital are both within the same NHS Trust (Western Sussex Hospitals NHS Foundation Trust) but are within different Neonatal ODN: St Richard's Hospital is within the Thames Valley & Wessex ODN and Worthing Hospital is within the South East Coast ODN. In order to align attribution of cases with denominator data, cases at St Richards Hospital were assigned to the South East Coast Neonatal ODN (rather than the Thames Valley & Wessex Neonatal ODN); this

[12] NMPA project team. National Maternity and Perinatal Audit: organisational report 2017. RCOG London, 2017. http://www.maternityaudit.org.uk/downloads/NMPA%20organisational%20report%202017.pdf accessed 3rd April 2019.

[13] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018. https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Perinatal%20Surveillance%20Full%20Report%20for%202016%20-%20June%202018.pdf accessed 12th February 2019

assignment is consistent with the MBRRACE-UK report (see section 2.4.3 for more detail).

2.4 Denominator data sources

2.4.1 National live births

To calculate national rates for 2016 and 2017, denominator data from the Office for National Statistics (ONS) Birth Summary Tables for England and Wales[14] where mothers' usual residence is England were used.

To calculate national rates for preterm and term births, ONS data describing total live births by gestational age (in weeks) for 2016 and 2017, where mothers' usual residence is England[15] were used. These data were also used as the denominator when calculating rates of medical conditions leading to *brain injuries occurring during or soon after birth* where gestational age is specified. Births were extracted from a dataset containing birth registrations linked to their corresponding notification and infants missing gestational age and where birth weight was inconsistent with gestational age were excluded. As a result, lower numbers of live births are reported for these analyses than for analyses that use the ONS Birth Summary Tables[11].

2.4.2 Regional live births by Sustainability and Transformation Partnerships and Local Maternity Systems

Total numbers of live births per LSOA for years 2016 and 2017 were obtained from the ONS NOMIS system[16]. These births were then mapped to their respective STP using the mapping data provided by the Department of Health and Social Care (Appendix 3).

2.4.3 Regional live births by Neonatal ODN

Neonatal ODN of birth could not be derived from ONS data for all births (e.g. home births or births in transit). Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK) is commissioned by the Healthcare Quality Improvement Partnership (HQIP) to undertake the Maternal, Newborn and Infant Clinical Outcome Review Programme on behalf of NHS England, the Welsh Government, the Scottish Government Health and Social Care Directorate, the Northern Ireland Department of Health, the States of Guernsey, the States of

[14] Office for National Statistics, last accessed 17th January 2019, https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/datasets/birthsummarytables
[15] Office for National Statistics, last accessed 20th January 2019; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/adhocs/009545livebirthsbygestationalagewheremothersusualresidencewasengland2016and2017
[16] Office for National Statistics, Official Labout Market Statistics. Accessed via: https://www.nomisweb.co.uk/

Jersey, and the Isle of Man Government. The MBBRACE-UK Perinatal Mortality Surveillance Reports provide birth data in England where births, including home births and births in transit, can be attributed to their respective Neonatal ODN. The 2016 report[17] provides both the total number of births and crude stillbirth rate in 2016 by Neonatal Network in England, permitting the calculation of total live births per Neonatal ODN. Total live births per Neonatal ODN are reported using the organisational structure of neonatal services applicable prior to March 2018 (see mapping tool in Appendix 2) and are used as the denominator for calculation of the rates of *brain injuries occurring during or soon after birth* by Neonatal ODN. Corresponding denominator data are not yet available for 2017. The fifth MBRRACE-UK Perinatal Mortality Surveillance Report will report total live births in 2017 by neonatal network and is expected later in 2019.

Figures for total live births per Neonatal ODN were calculated from the MBRRACE-UK data and do not include births from The Portland Hospital for Women and Children (HCA Healthcare UK) or RAF Lakenheath (48th Medical Group) as neither of these sites are part of a Neonatal ODN. Home births were allocated to the Trust responsible and then included in the appropriate Neonatal ODN for that Trust. Total live births in England from MBRRACE-UK do not align perfectly with estimates from ONS data.

Western Sussex Hospitals NHS Foundation Trust has two neonatal units on two different hospital sites (St Richards Hospital and Worthing Hospital) and these are within different Neonatal ODN; St Richards Hospital forms part of the Thames Valley & Wessex Neonatal ODN and Worthing Hospital forms part of the South East Coast Neonatal ODN. MBRRACE-UK assigns births at St. Richards Hospital to the South East Coast Neonatal ODN (rather than the Thames Valley & Wessex Neonatal ODN). To maintain consistency we present data describing rates of *brain injuries occurring during or soon after birth* by Neonatal ODN to align with the mapping of Trust to Neonatal ODN used by MBRRACE-UK (i.e. St Richard's Hospital is mapped to South East Coast Neonatal ODN).

From MBRRACE-UK it was possible to obtain estimates of total births from St Richard's Hospital for 2016. Using these data we undertook a sensitivy analysis in which we reassigned cases of brain injuries and denominator live births for St Richard's Hospital to Thames Valley & Wessex ODN and explored the impact of this reassignment on rates of *brain injuries occurring during or soon after birth* per 1,000 live births for both South East Coast ODN and Thames Valley & Wessex ODN.

[17] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018. https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Perinatal%20Surveillance%20Full%20Report%20for%202016%20-%20June%202018.pdf accessed 12th February 2019

2.5 Statistical methods

We present rates of brain injuries per 1,000 live births unless otherwise stated. For years 2012-2015, rates of brain injuries were calculated as described previously[18].

Confidence intervals (CI) for rates have been calculated using the following method:

1) Calculate error factor (EF):

$$EF = e^{(1.96/\sqrt{D})}$$

$$where\ D = number\ of\ brain\ injuries$$

2) Calculate lower and upper CI:

$$Lower\ CI = Rate \div EF$$

$$Upper\ CI = Rate \times EF$$

[18] Gale C, Statnikov Y, Jawad S et al on behalf of the Brain Injuries expert working group, Neonatal brain injuries in England: population-based incidence derived from routinely recorded clinical data held in the National Neonatal Research Database. *Archives of Disease in Childhood - Fetal and Neonatal Edition* https://fn.bmj.com/content/early/2017/10/22/archdischild-2017-313707

3 Results

3.1 National rates of brain injuries

3.1.1 Rates of brain injuries in England: all gestational ages

Numerator:	Annual number of infants who received at least one episode of care within a neonatal unit in England with a *brain injury occurring during or soon after birth*, with and without exclusions, obtained from the NNRD.
Denominator:	Annual number of live births in England obtained from ONS Birth Summary Tables[19].

Table 1 presents the incidence and crude rates per 1,000 live births of brain injuries, with and without exclusions of infants with conditions leading to brain injury prior to birth, for years 2012 to 2017. Figure 1 displays the crude rates of brain injuries per 1,000 live births prior to exclusions.

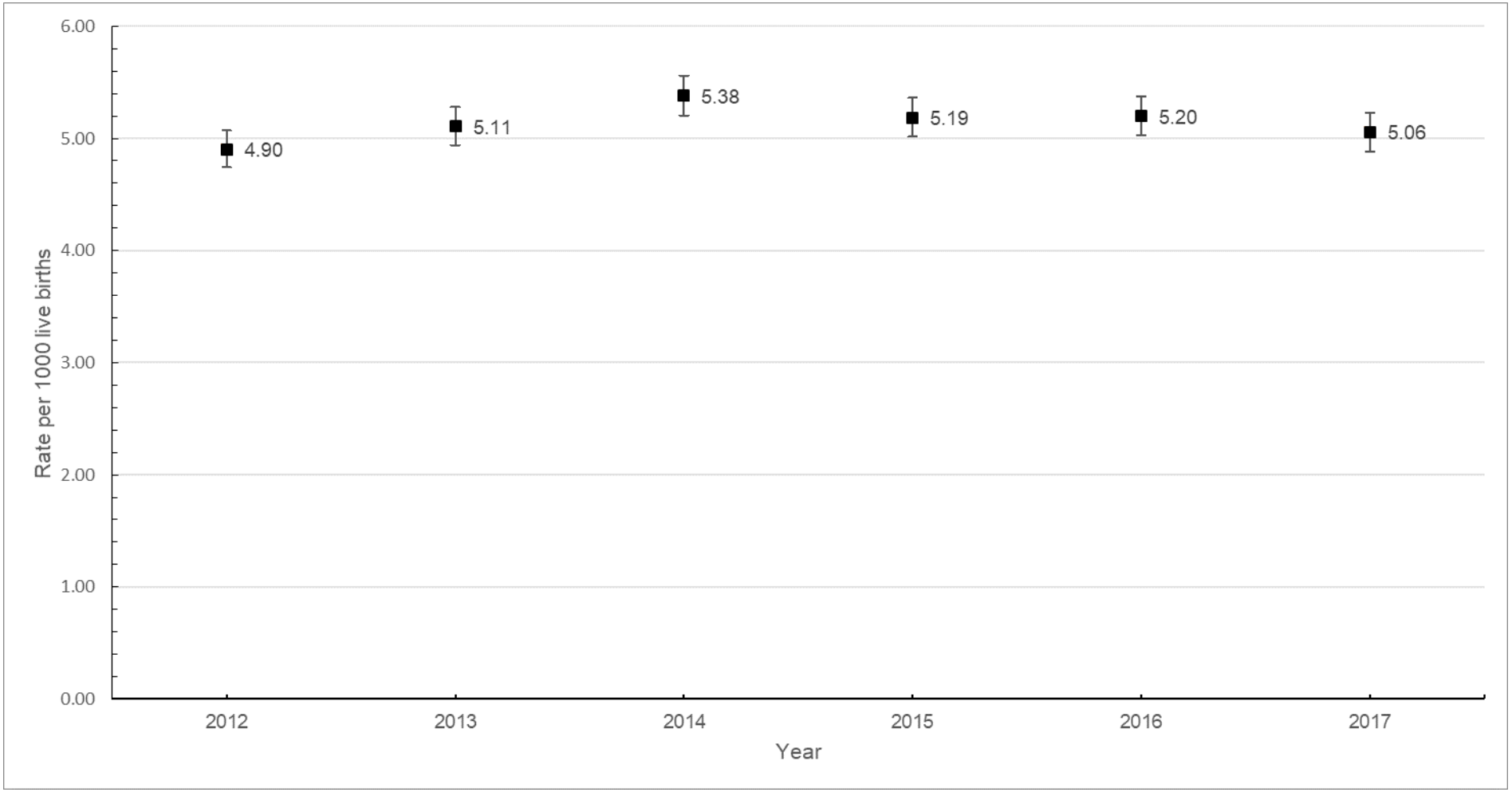
[19] Office for National Statistics, last accessed 17th January 2019, https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/datasets/birthsummarytables

Table 1: Infants in England (all gestational ages) with a diagnosis of brain injury, before and after exclusion of infants with conditions leading to brain injury prior to birth.

Year	Infants recorded in the NNRD	Infants recorded in the NNRD with GA available (%)	Live births in England	Before exclusion of infants with conditions leading to brain injury prior to birth		After exclusion of infants with conditions leading to brain injury prior to birth		
				Infants with brain injury	Rate of brain injuries per 1,000 live births (95%CI)	Exclusions	Infants with brain injury	Rate of brain injuries per 1,000 live births (95% CI)
2012	78,980	78,952 (99.96)	694,241	3,404	**4.90** (4.74*, 5.07)	45	3,359	**4.84** (4.68, 5.00)
2013	80,222	80,199 (99.97)	664,517	3,393	**5.11** (4.94, 5.28)	35	3,358	**5.05** (4.89, 5.23)
2014	85,013	84,981 (99.96)	661,496	3,558	**5.38** (5.20, 5.56)	30	3,528	**5.33** (5.16, 5.51)
2015	88,931	88,785 (99.84)	664,399	3,445	**5.19** (5.01, 5.36)	27	3,418	**5.14** (4.97, 5.32)
2016	92,582	92,487 (99.90)	663,157	3,446	**5.20** (5.03, 5.37)	65	3,381	**5.10** (4.93, 5.27)
2017	97,405	97,341 (99.93)	646,794	3,270	**5.06** (4.89, 5.23)	57	3,213	**4.97** (4.80, 5.14)

Abbreviations: CI: confidence interval, GA: gestational age
*Error in previously published report where lower CI was reported as 4.47

Figure 1: Annual rates of brain injury occurring during or soon after birth in England (all gestational ages) 2012-2017 without exclusions; error bars indicate 95% confidence intervals



3.1.2 Rates of brain injuries in England: term infants

Numerator:	Annual number of term infants (≥37 weeks gestational age) who received at least one episode of care within a neonatal unit in England with a *brain injury occurring during or soon after birth* in England, with and without exclusions, obtained from the NNRD.
Denominator:	Annual number of term live births in England obtained from ONS Live Births by Gestational Age[20].

Table 2 presents the incidence and crude rates per 1,000 live term births of brain injuries in term infants, with and without exclusions of infants with conditions leading to brain injury prior to birth, for years 2012 to 2017. Figure 2 displays the crude rates of brain injuries in term infants per 1,000 live term births, prior to exclusions.

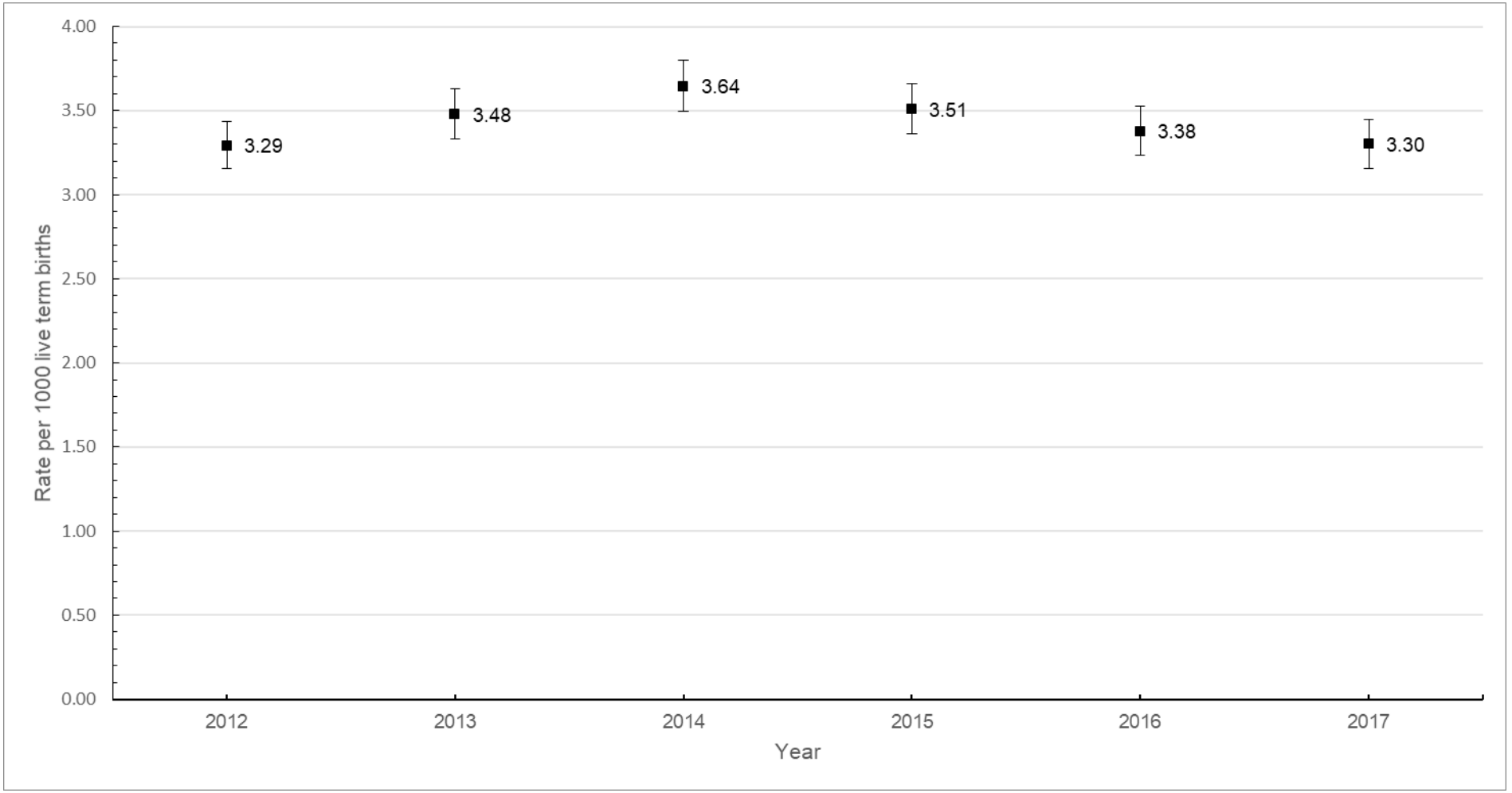
[20] Office for National Statistics, last accessed 20th January 2019; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/adhocs/009545livebirthsbygestationalagewheremothersusualresidencewasengland2016and2017

Table 2: Term infants in England (≥37 weeks gestational age) with a diagnosis of brain injury, before and after exclusion of infants with conditions leading to brain injury prior to birth.

			Before exclusion of infants with conditions leading to brain injury prior to birth		After exclusion of infants with conditions leading to brain injury prior to birth		
Year	**Term infants recorded in the NNRD**	**Term live births in England**	**Term infants with brain injury**	**Rate of brain injuries per 1,000 term live births (95%CI)**	**Exclusions**	**Term Infants with brain injury**	**Rate of brain injuries per 1,000 term live births (95% CI)**
2012	46,200	640,787	2,109	**3.29** (3.15, 3.43)	35	2,074	**3.24** (3.10, 3.38)
2013	47,935	612,816	2,130	**3.48** (3.33, 3.63)	25	2,105	**3.43** (3.29, 3.58)
2014	51,945	607,972	2,215	**3.64** (3.49, 3.80)	26	2,189	**3.60** (3.45, 3.75)
2015	55,045	609,076	2,136	**3.51** (3.36, 3.66)	20	2,116	**3.47** (3.33, 3.63*)
2016	58,069	609,118	2,057	**3.38** (3.23, 3.53)	38	2,019	**3.31** (3.17, 3.46)
2017	62,558	593,339	1,957	**3.30** (3.16, 3.45)	42	1,915	**3.23** (3.09, 3.38)

Abbreviations: CI: confidence interval
*Error in previously published report where upper CI was reported as 3.62

Figure 2: Annual rates of brain injury occurring during or soon after birth in England in term infants (≥37 gestational weeks) 2012-2017 without exclusions; error bars indicate 95% confidence interva



3.1.3 Rates of brain injuries in England: preterm infants

Numerator:	Annual number of preterm infants (<37 weeks gestational age) who received at least one episode of care within a neonatal unit in England with a *brain injury occurring during or soon after birth* in England, with and without exclusions, obtained from the NNRD.
Denominator:	Annual number of preterm live births in England obtained from ONS Live Births by Gestational Age[21].

Table 3 presents the incidence and crude rates per 1,000 live preterm births of brain injuries in preterm infants, with and without exclusions of infants with conditions leading to brain injury prior to birth, for years 2012 to 2017. Figure 3 displays the crude rates of brain injuries in preterm infants per 1,000 live preterm births, prior to exclusions.

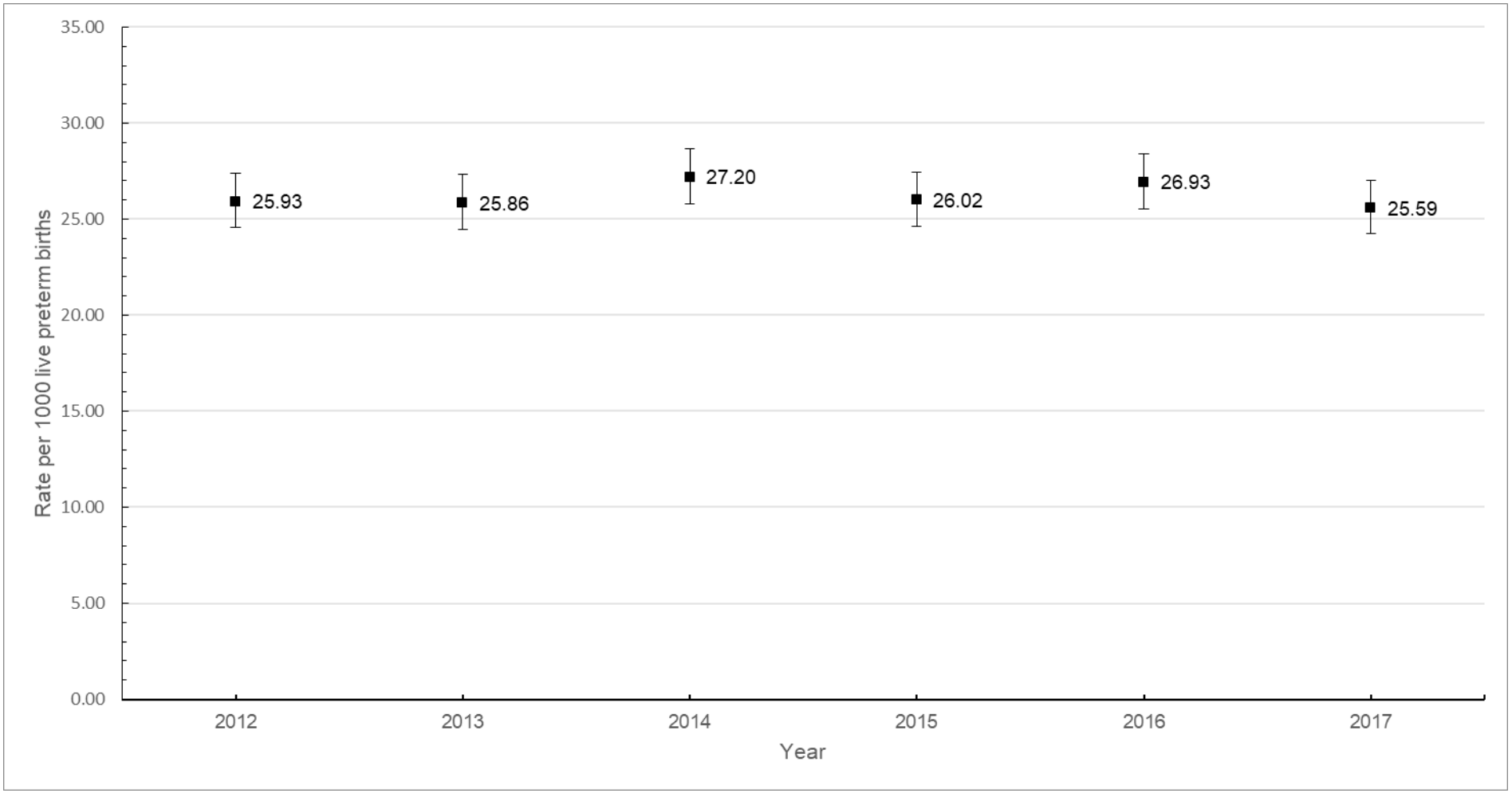
[21] Office for National Statistics, last accessed 20th January 2019; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/adhocs/009545livebirthsbygestationalagewheremothersusualresidencewasengland2016and2017

Table 3: Preterm infants in England (<37 weeks gestational age) with a diagnosis of brain injury, before and after exclusion of infants with conditions leading to brain injury prior to birth.

			Before exclusion of infants with conditions leading to brain injury prior to birth		After exclusion of infants with conditions leading to brain injury prior to birth		
Year*	**Preterm infants recorded in the NNRD**	**Preterm live births in England**	**Preterm infants with brain injury**	**Rate of brain injuries per 1,000 term live births (95%CI)**	**Exclusions**	**Preterm infants with brain injury**	**Rate of brain injuries per 1,000 preterm live births (95% CI)**
2012	32,752	49,949	1,295	**25.93** (24.55, 27.38)	10	1,285	**25.73** (24.36, 27.17)
2013	32,264	48,844	1,263	**25.86** (24.47, 27.32)	10	1,253	**25.65** (24.27, 27.11)
2014	33,036	49,379	1,343	**27.20** (25.78, 28.69)	4	1,339	**27.12** (25.70, 28.61)
2015	33,740	50,308	1,309	**26.02** (24.65, 27.47)	7	1,302	**25.88** (24.51, 27.33)
2016	34,418	51,581	1,389	**26.93** (25.55, 28.38)	27	1,362	**26.41** (25.04, 27.85)
2017	34,783	51,307	1,313	**25.59** (24.24, 27.01)	15	1,298	**25.30** (23.96, 26.71)

Abbreviations: NNRD: National Neonatal Research Database; CI: confidence interval

Figure 3: Annual rates of brain injury occurring during or soon after birth in England in preterm infants (<37 gestational weeks) 2012-2017 without exclusions; error bars indicate 95% confidence intervals



3.1.4 Rates of brain injuries in England by medical condition

Numerators:	Number of infants who received at least one instance of care within a neonatal unit in England with individual conditions included in the definition of *brain injuries occurring during or soon after birth* obtained from the NNRD: 1. All gestational ages 2. Term births only (≥37 gestational weeks) 3. Preterm births only (<37 gestational weeks)
Denominators:	1. Annual number of live births in England obtained from ONS Birth Summary Tables[22]. 2. Annual number of term live births in England obtained from ONS Live Births by Gestational Age[23]. 3. Number of preterm live births in England obtained from ONS Live Births by Gestational Age[18].

Tables 4 - 10 present the national rates of different medical conditions leading to brain injury at or soon after birth. Further explanation of way different medical conditions are defined, including the relevant NNRD data items, can be found in Appendix 1. It was possible for infants to be diagnosed with more than one condition leading to brain injury at or soon after birth, so the sum of total number of cases in tables 4 to 9 will not match totals in tables 1 to 3.

It is important to note that the the definition of hypoxic ischaemic encephalopathy (HIE) included within the definition of *brain injuries occurring during or soon after birth* is different from the definition used in other national reports (e.g. the National Neonatal Audit Programme audit measure *encephalopathy*[24] and Each Baby Counts outcome *Severe brain injury*[25]).

Low numbers of annual cases of *bilirubin encephalopathy* were reported. To ensure confidentiality and prevent disclosure of protected information cases of *bilirubin encephalopathy* are presented in aggregate over the six year period between 2012 and 2017.

[22] Office for National Statistics, last accessed 17th January 2019, https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/datasets/birthsummarytables
[23] Office for National Statistics, last accessed 20th January 2019; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/adhocs/009545livebirthsbygestationalagewheremothersusualresidencewasengland2016and2017
[24] National Neonatal Audit Programme A guide to the 2018 audit measures; v1.2 published November 2018, last accessed 21st March 2019; https://www.rcpch.ac.uk/sites/default/files/2018-11/NNAP%202018%20Audit%20Measures%20Guide%20v1.2%20FINAL.pdf
[25] Royal College of Obstetricians and Gynaecologists. Each Baby Counts: 2015 Full Report. London: RCOG, 2017, last accessed 21st March 2019; https://www.rcog.org.uk/en/guidelines-research-services/audit-quality-improvement/each-baby-counts/ebc-2015-report/

Table 4: Infants in England with hypoxic ischaemic encephalopathy (HIE)

HIE	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
All Cases	1,674	1,674	1,824	1,742	1,673	1,576
Rate per 1,000 live births (95% CI)	**2.41** (2.30, 2.53)	**2.52** (2.40, 2.64)	**2.76** (2.63, 2.89)	**2.62** (2.50, 2.75)	**2.52** (2.40, 2.65)	**2.44** (2.32, 2.56)
Term cases	1,409	1,401	1,480	1,417	1,348	1,274
Preterm cases	265	273	344	325	325	302

Abbreviations: CI: confidence interval

Table 5: Infants in England with seizures

Seizures	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
All Cases	1,445	1,432	1,360	1,249	1,223	1,159
Rate per 1,000 live births (95% CI)	**2.08** (1.98, 2.19)	**2.15** (2.05, 2.27)	**2.06** (1.95, 2.17)	**1.88** (1.78, 1.99)	**1.84** (1.74, 1.95)	**1.79** (1.69, 1.90)
Term cases	1,065	1,036	1,009	919	866	845
Preterm cases	378	396	351	330	357	314

Abbreviations: CI: confidence interval

Table 6: Infants in England with intracranial haemorrhage

Intracranial Haemorrhage	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
All Cases	754	677	689	726	777	783
Rate per 1,000 live births (95% CI)	**1.09** (1.01, 1.17)	**1.02** (0.94, 1.10)	**1.04** (0.97, 1.12)	**1.09** (1.02, 1.18)	**1.17** (1.09, 1.26)	**1.21** (1.13, 1.30)
Term cases	110	94	104	117	112	129
Preterm cases	644	583	585	609	665	654
Severe P/IVH <32 weeks GA	483	445	468	452	519	482
Rate of severe P/IVH per 1,000 live births <32 weeks GA (95% CI)	**60.35** (55.20, 65.98)	**57.72** (52.60, 63.35)	**61.13** (55.83, 66.93)	**58.27** (53.14, 63.90)	**61.76** (56.67, 67.31)	**58.64** (53.64, 64.12)

Abbreviations: CI: confidence interval

Table 7: Infants in England with central nervous system (CNS) infection

CNS Infection	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
All Cases	353	422	504	465	524	469
Rate per 1,000 live births (95% CI)	**0.51** (0.46, 0.56)	**0.64** (0.58, 0.70)	**0.76** (0.70, 0.83)	**0.70** (0.64, 0.77)	**0.79** (0.73, 0.86)	**0.73** (0.66, 0.79)
Term cases	188	266	284	277	303	264
Preterm cases	165	156	220	188	221	205

Abbreviations: CI: confidence interval

Table 8: Infants in England with perinatal/neonatal stroke

Perinatal/ Neonatal Stroke	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
All Cases	77	100	88	90	82	91
Rate per 1,000 live births (95% CI)	**0.11** (0.09, 0.14)	**0.15** (0.12, 0.18)	**0.13** (0.11, 0.16)	**0.14** (0.11, 0.17)	**0.12** (0.10, 0.15)	**0.14** (0.11, 0.17)
Term cases	64	78	72	76	66	74
Preterm cases	13	22	16	14	16	17

Abbreviations: CI: confidence interval

Table 9: Infants in England with cystic perventricular leukomalacia (PVL)

Cystic PVL	Year					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
Preterm cases	199	175	171	184	210	175
Rate per 1,000 live births (95% CI)	**0.3** (0.3, 0.3)	**0.3** (0.2, 0.3)	**0.3** (0.2, 0.3)	**0.3** (0.2, 0.3)	**0.3** (0.3, 0.4)	**0.3** (0.2, 0.3)
Cases at <34 weeks GA	186	175	157	176	201	171
Rate per 1,000 live births <34 weeks GA (95% CI)	**12.7** (11.0, 14.7)	**12.5** (10.7, 14.4)	**11.3** (9.7, 13.3)	**12.4** (10.7, 14.4)	**13.8** (12.0, 15.8)	**11.8** (10.2, 13.7)

Abbreviations: CI: confidence interval; GA: gestational age

Table 10: Infants in England with bilirubin encephalopathy

Bilirubin Encephalopathy	Year
	2012 – 2017
All Cases	25
Annual rate per 100,000 live births (95% CI)	**0.63** (0.42, 0.93)

Abbreviations: CI: confidence interval. Note: Due to low numbers of cases, data from 2012 to 2017 were merged.

3.2 Regional rates of brain injuries by Sustainability and Transformation Partnerships and Local Maternity System

Numerator:	Annual number of infants with *brain injuries occurring during or soon after birth*, without exclusions, attributed by LSOA of mother's residence in England at time of birth. Obtained from the NNRD and mapped to STP/LMS using data in Appendix 3.
Denominator:	Annual number of live births in England obtained from ONS NOMIS[26] and mapped to STP/LMS using data in Appendix 3.

Tables 11 and 12 present the rates of *brain injuries occurring during or soon after birth* per 1,000 live births across the 42 STP/LMS associated with mother's residence at time of birth in England in 2016 and 2017 respectively.

[26] Office for National Statistics, Official Labout Market Statistics. Accessed via: https://www.nomisweb.co.uk/

Table 11: Infants (all gestational ages) in 2016 with a diagnosis of *brain injuries occurring during or soon after birth*, without exclusions, by Sustainability and Transformation Partnership (STP), attributed by Lower Super Output Area (LSOA) of the mother's residence in England at the time of delivery

Sustainability & Transformation Partnership (STP)	2016			
	Number of Live Births	Number of brain injuries	Rate of brain injuries per 1,000 live births	95% CI
Bath, Swindon and Wiltshire	9,885	73	**7.38**	(5.87, 9.29)
Birmingham and Solihull	16,744	100	**5.97**	(4.91, 7.27)
Bristol, North Somerset and South Gloucestershire	11,678	74	**6.34**	(5.05, 7.96)
Buckinghamshire, Oxfordshire and Berkshire West	19,751	91	**4.61**	(3.75, 5.66)
Cambridgeshire and Peterborough	10,707	45	**4.20**	(3.14, 5.63)
Cheshire and Merseyside	27,383	115	**4.20**	(3.50, 5.04)
Cornwall and the Isles of Scilly	5,312	25	**4.71**	(3.18, 6.97)
Coventry and Warwickshire	10,482	24	**2.29**	(1.53, 3.42)
Cumbria and North East	33,058	119	**3.60**	(3.01, 4.31)
Derbyshire	10,757	47	**4.37**	(3.28, 5.82)
Devon	11,190	63	**5.63**	(4.40, 7.21)
Dorset	7,161	34	**4.75**	(3.39, 6.64)
Frimley Health	9,466	46	**4.86**	(3.64, 6.49)
Gloucestershire	6,739	25	**3.71**	(2.51, 5.49)
Greater Manchester	37,246	190	**5.10**	(4.43, 5.88)
Hampshire and the Isle of Wight	19,181	93	**4.85**	(3.96, 5.94)
Herefordshire and Worcestershire	7,837	29	**3.70**	(2.57, 5.32)
Hertfordshire and West Essex	18,162	90	**4.96**	(4.03, 6.09)
Humber, Coast and Vale	14,404	56	**3.89**	(2.99, 5.05)
Kent and Medway	21,031	121	**5.75**	(4.81, 6.88)
Lancashire and South Cumbria	18,741	90	**4.80**	(3.91, 5.90)
Leicester, Leicestershire and Rutland	12,603	62	**4.92**	(3.84, 6.31)

Table 11 continued: Infants (all gestational ages) in 2016 with a diagnosis of *brain injuries occurring during or soon after birth*, without exclusions, by Sustainability and Transformation Partnership (STP), attributed by Lower Super Output Area (LSOA) of the mother's residence in England at the time of delivery

Sustainability & Transformation Partnership (STP)	2016			
	Number of Live Births	Number of brain injuries	Rate of brain injuries per 1,000 live births	95% CI
Lincolnshire	7,485	46	**6.15**	(4.60, 8.20)
Mid and South Essex	13,989	65	**4.65**	(3.64, 5.93)
Milton Keynes, Bedfordshire and Luton	12,831	56	**4.36**	(3.36, 5.67)
Norfolk and Waveney	10,218	39	**3.82**	(2.79, 5.22)
North Central London	20,092	96	**4.78**	(3.91, 5.84)
North East London	31,998	190	**5.94**	(5.15, 6.85)
North West London	29,753	160	**5.38**	(4.61, 6.28)
Northamptonshire	8,970	37	**4.12**	(2.99, 5.69)
Nottinghamshire	11,710	94	**8.03**	(6.56, 9.83)
Shropshire and Telford and Wrekin	5,026	18	**3.58**	(2.26, 5.68)
Somerset	5,470	24	**4.39**	(2.94, 6.55)
South East London	25,471	155	**6.09**	(5.20, 7.12)
South West London	21,489	127	**5.91**	(4.97, 7.03)
South Yorkshire and Bassetlaw	17,277	94	**5.44**	(4.44, 6.66)
Staffordshire	12,190	54	**4.43**	(3.39, 5.78)
Suffolk and North East Essex	10,191	68	**6.67**	(5.26, 8.46)
Surrey Heartlands	9,563	45	**4.71**	(3.51, 6.30)
Sussex and East Surrey	19,166	89	**4.64**	(3.77, 5.72)
The Black Country	18,762	127	**6.77**	(5.69, 8.05)
West Yorkshire	31,988	131	**4.10**	(3.45, 4.86)
Missing		*119*		
TOTAL	663,157	3446	**5.20**	(5.03, 5.37)

Table 12: Infants (all gestational ages) in 2017 with a diagnosis of *brain injuries occurring during or soon after birth*, without exclusions, by Sustainability and Transformation Partnership (STP), attributed by Lower Super Output Area (LSOA) of the mother's residence in England at the time of delivery.

Sustainability & Transformation Partnership (STP)	2017			
	Number of Live Births	Number of brain injuries	Rate of brain injuries per 1,000 live births	95% CI
Bath, Swindon and Wiltshire	9,469	55	**5.81**	(4.46, 7.57)
Birmingham and Solihull	15,972	84	**5.26**	(4.25, 6.51)
Bristol, North Somerset and South Gloucestershire	11,211	72	**6.42**	(5.10, 8.09)
Buckinghamshire, Oxfordshire and Berkshire West	19,025	72	**3.78**	(3.00, 4.77)
Cambridgeshire and Peterborough	10,355	51	**4.93**	(3.74, 6.48)
Cheshire and Merseyside	27,091	141	**5.20**	(4.41, 6.14)
Cornwall and the Isles of Scilly	5,162	30	**5.81**	(4.06, 8.31)
Coventry and Warwickshire	10,413	41	**3.94**	(2.90, 5.35)
Cumbria and North East	31,831	115	**3.61**	(3.01, 4.34)
Derbyshire	10,415	59	**5.66**	(4.39, 7.31)
Devon	11,111	67	**6.03**	(4.75, 7.66)
Dorset	7,113	23	**3.23**	(2.15, 4.87)
Frimley Health	9,016	50	**5.55**	(4.20, 7.32)
Gloucestershire	6,537	31	**4.74**	(3.34, 6.74)
Greater Manchester	36,092	190	**5.26**	(4.57, 6.07)
Hampshire and the Isle of Wight	18,683	74	**3.96**	(3.15, 4.97)
Herefordshire and Worcestershire	7,635	31	**4.06**	(2.86, 5.77)
Hertfordshire and West Essex	17,741	75	**4.23**	(3.37, 5.30)
Humber, Coast and Vale	13,880	57	**4.11**	(3.17, 5.32)
Kent and Medway	21,068	104	**4.94**	(4.07, 5.98)
Lancashire and South Cumbria	18,023	86	**4.77**	(3.86, 5.89)
Leicester, Leicestershire and Rutland	12,198	50	**4.10**	(3.11, 5.41)

Table 12 continued: Infants (all gestational ages) in 2017 with a diagnosis of *brain injuries occurring during or soon after birth*, without exclusions, by Sustainability and Transformation Partnership (STP), attributed by Lower Super Output Area (LSOA) of the mother's residence in England at the time of delivery.

Sustainability & Transformation Partnership (STP)	2017			
	Number of Live Births	Number of brain injuries	Rate of brain injuries per 1,000 live births	95% CI
Lincolnshire	7,485	43	**5.74**	(4.26, 7.75)
Mid and South Essex	13,975	70	**5.01**	(3.96, 6.33)
Milton Keynes, Bedfordshire and Luton	12,415	52	**4.19**	(3.19, 5.50)
Norfolk and Waveney	9,798	47	**4.80**	(3.60, 6.38)
North Central London	19,402	95	**4.90**	(4.00, 5.99)
North East London	31,636	160	**5.06**	(4.33, 5.91)
North West London	29,165	148	**5.07**	(4.32, 5.96)
Northamptonshire	8,775	45	**5.13**	(3.83, 6.87)
Nottinghamshire	11,517	70	**6.08**	(4.81, 7.68)
Shropshire and Telford and Wrekin	4,872	15	**3.08**	(1.86, 5.11)
Somerset	5,367	36	**6.71**	(4.84, 9.30)
South East London	25,183	130	**5.16**	(4.35, 6.13)
South West London	20,922	108	**5.16**	(4.27, 6.23)
South Yorkshire and Bassetlaw	16,968	78	**4.60**	(3.68, 5.74)
Staffordshire	11,784	50	**4.24**	(3.22, 5.60)
Suffolk and North East Essex	10,126	54	**5.33**	(4.08, 6.96)
Surrey Heartlands	9,245	34	**3.68**	(2.63, 5.15)
Sussex and East Surrey	18,421	91	**4.94**	(4.02, 6.07)
The Black Country	18,655	129	**6.92**	(5.82, 8.22)
West Yorkshire	31,042	146	**4.70**	(4.00, 5.53)
Missing		*111*		
TOTAL	646,794	3270	**5.06**	(4.89, 5.23)

3.3 Regional rates of brain injuries by Neonatal Operational Delivery Network

Numerator:	Annual number of infants with *brain injuries occurring during or soon after birth* in England, without exclusions, attributed by Neonatal ODN of birth. Obtained from the NNRD and mapped to Neonatal ODN using data in Appendix 2.
Denominator:	Annual number of live births in England by Neonatal ODN caclulated using total birth and crude stillbirth rate obtained from MBRRACE-UK[27].

Table 13 presents the rates of *brain injuries occurring during or soon after birth* per 1,000 live births in 2016 across Neonatal ODN, where place of birth was in England.

Table 14 presents the adjusted rates of *brain injuries occurring during or soon after birth* per 1,000 live births in 2016 for South East Coast Neonatal ODN and Thames Valley & Wessex Neonatal ODN when reassigning the estimates for brain injuries and live births at St Richard's Hospital to the Thames Valley & Wessex Neonatal ODN. To note, the crude stillbirth rate for St Richard's Hospital was not available from the MBRRACE-UK data so the stillbirth rate for Western Sussex Hospitals NHS Foundation Trust was used as a proxy. Also, the adjusted rates for both South East Coast Neonatal ODN and Thames Valley & Wessex Neonatal ODN exclude any home births that would have been attributed to St Richard's Hospital.

[27] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018. https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Perinatal%20Surveillance%20Full%20Report%20for%202016%20-%20June%202018.pdf accessed 12th February 2019

Table 13: Infants in England (all gestational ages) in 2016 with a diagnosis of brain injury, without exclusions, attributed by Neonatal ODN of place of birth; congruent with organisational structure of neonatal services prior to March 2018

	2016					
Neonatal ODN	**Total Births**	**Crude Stillbirth Rate per 1,000 births**	**Estimated Live Births**	**Infants with brain injuries**	**Rate of brain injuries per 1,000 live births**	**95% CI**
East of England	69,838	3.75	69,576	345	4.96	(4.46, 5.51)
London	132,210	4.45	131,621	767	5.83	(5.43, 6.25)
North Central & East London	*54,881*	*4.81*	*54,617*	*300*	*5.49*	*(4.91, 6.15)*
North West London	*32,187*	*4.69*	*32,036*	*175*	*5.46*	*(4.71, 6.33)*
South London	*45,142*	*3.85*	*44,968*	*292*	*6.49*	*(5.79, 7.28)*
North West	84,719	3.80	84,397	417	4.94	(4.49, 5.44)
Northern	32,929	3.04	32,829	123	3.75	(3.14, 4.47)
South East Coast*	49,146	3.36	48,981	278	5.68	(5.05, 6.38)
South West	48,937	3.17	48,782	300	6.15	(5.49, 6.89)
Southern West Midlands	31,922	4.98	31,763	176	5.54	(4.78, 6.42)
Staffordshire, Shropshire, & Black Country	25,462	3.61	25,370	147	5.79	(4.93, 6.81)
Thames Valley & Wessex*	60,756	3.54	60,541	279	4.61	(4.10, 5.18)
Trent Perinatal & Central Neonatal	58,655	4.01	58,420	293	5.02	(4.47, 5.62)
Yorkshire & Humber	67,838	4.66	67,522	304	4.50	(4.02, 5.04)
TOTAL	**662,412**	**4.30**	**659,802**	**3,429**†	**5.20**	**(5.03, 5.37)**

Abbreviations: ODN: operational delivery network; CI: confidence interval
*South East Coast ODN estimates also include total births, live births and numbers of infants with brain injuries associated with St Richard's Hospital which should instead be assigned to Thames Valley & Wessex. †17 infants with brain injuries were excluded from the ODN analysis as they were not born in English NHS units.

Table 14: Results of sensitivity analysis reassigning births and brain injuries associated with St Richard's Hospital to Thames Valley & Wessex Neonatal ODN (from South East Coast ODN), adjusted rates of brain injuries per 1,000 live births.

Year	Total Births: St Richard's Hospital	Crude Stillbirth Rate per 1,000 births: Western Sussex NHS Trust	Estimated Live Births: St Richard's Hospital	Total Number of Brain Injuries: St Richard's Hospital	Adjusted Rate (95% CI) of brain injuries per 1,000 births: South East Coast Neonatal ODN	Adjusted Rate (95% CI) of brain injuries per 1,000 live births: Thames Valley & Wessex Neonatal ODN
2016	2,629	4.15	2,618	6	5.87 (5.21, 6.61)	4.51 (4.02, 5.07)

Appendix 1: Definition of brain injuries occurring during or soon after birth using the National Neonatal Research Database (NNRD)

Appendix 1

Brain injury definition: National Neonatal Research Database (NNRD) data fields

Scope

- All babies admitted to a NHS neonatal unit in England
- Injury detected during neonatal unit stay to discharge
- Annual data, from January 1st 2016 to December 31st 2017 (inclusive)

Data source

- Data extracted from the National Neonatal Research Database (NNRD) at the Neonatal Data Analysis Unit at Imperial College London.
- The NNRD contains a predefined set of variables (the Neonatal Data Set, an authorised NHS Information Standard) extracted at regular intervals from the Electronic Patient Record of every admission to a NHS neonatal unit in England, Wales, and Scotland, cleaned and merged across multiple patient episodes, to create a single data file for each patient.

Appendix 1: Definition of brain injuries occurring during or soon after birth using the National Neonatal Research Database (NNRD)

Condition	Data items
HIE	Any of the following recorded in any *Diagnosis* field: 1. Severe Hypoxic Ischaemic Encephalopathy (HIE) 2. Severe Neonatal Encephalopathy 3. Grade 3 Hypoxic Ischaemic Encephalopathy (HIE) 4. Moderate Hypoxic Ischaemic Encephalopathy (HIE) 5. Moderate Neonatal Encephalopathy 6. Grade 2 Hypoxic Ischaemic Encephalopathy (HIE) **OR** The following recorded in *daily care neurology* field: 1. Therapeutic hypothermia induced - for 2 or more consecutive days
Intracranial haemorrhage	Any of the following recorded in any *Diagnosis* field: 1. Subdural haemorrhage due to birth injury 2. Cerebral haemorrhage due to birth injury 3. Traumatic intraventricular haemorrhage 4. Subarachnoid haemorrhage due to birth injury 5. Subarachnoid haemorrhage 6. Tentorial tear due to birth injury 7. Intracranial laceration and haemorrhage due to birth injury 8. Large intraventricular haemorrhage (IVH Grade 3) 9. Intraventricular haemorrhage/parenchymal 10. Parenchymal haemorrhage 11. haemorrhage (IVH Grade 4) 12. Intracranial Haemorrhage (unknown or unspecified cause) 13. Intracerebral haemorrhage 14. Intracerebral haemorrhage (term infant) 15. Intraventricular haemorrhage (perinatal) 16. Post-haemorrhagic hydrocephalus **OR** Any of the following recorded in any *cranial ultrasound findings* field: 1. Large intraventricular haemorrhage (IVH Grade 3) 2. Intraventricular haemorrhage/parenchymal haemorrhage (IVH Grade 4) 3. Parenchymal haemorrhage **OR** Any of the following recorded in any *procedure field*: 1. Ventriculoperitoneal or other ventricular shunt 2. External ventricular drain 3. Ventricular drain with reservoir 4. Insertion of ventricular peritoneal shunt.

Appendix 1: Definition of brain injuries occurring during or soon after birth using the National Neonatal Research Database (NNRD)

	5. Insertion of Rickham reservoir 6. Insertion of ventriculo-atrial CSF shunt 7. Insertion of ventriculo-peritoneal CSF shunt 8. Creation of ventriculoperitoneal shunt
Preterm white matter injury	Any of the following recorded in any *Diagnosis* field: 1. Cystic periventricular leukomalacia **OR** Any of the following recorded in any *cranial ultrasound findings* field: 1. Cystic periventricular leucomalacia
Perinatal stroke	Any of the following recorded in any *Diagnosis at discharge* field: 1. Neonatal stroke 2. Infarction: Middle cerebral artery (stroke) 3. Cerebrovascular accident (stroke) 4. Cerebral venous thrombosis 5. Neonatal cerebral ischaemia
Central nervous system infection	Any of the following diagnosis codes recorded in the *Diagnosis* field: 1. Bacterial meningitis 2. Viral meningitis 3. Meningitis – streptococcal 4. Meningitis – bacterial (specific organism) 5. Meningitis – bacterial (unknown or unspecified organism) 6. Meningitis – Candida 7. Candida encephalitis 8. Congenital herpes infection Any pathogen recorded in the *suspected infection data* field *Pathogen in CSF*
Kernicterus	Any of the following diagnoses recorded in any *Diagnosis* field: 1. Bilirubin encephalopathy (immune) 2. Kernicterus (unspecified or unknown cause) 3. Kernicterus
Seizures	Any of the following recorded in any *daily care neurology* field: 1. Seizure occurred

Appendix 1: Definition of brain injuries occurring during or soon after birth using the National Neonatal Research Database (NNRD)

Exclusions

Data will be presented before and after exclusion of infants with **seizures** (condition defined as above) AND the following diagnosis codes recorded in the *Diagnosis* field during their their neonatal unit admission.

Condition	Data items
Congenital encephalopathies	**Episodic variables:** Any of the following diagnosis codes entered into any *Diagnosis* field: 1. Congenital neuropathy (unknown or unspecified cause) 2. Congenital myopathy 3. Mitochondrial myopathy 4. Congenital Central Hypoventilation Syndrome (CCHS) 5. Congenital hypertonia 6. Congenital hypotonia - floppy 7. Benign familial neonatal seizures 8. Inborn error of metabolism (description required) 9. Myotonic dystrophy requiring endotracheal intubation and assisted ventilation 10. Disorder of branch chain amino acid metabolism 11. Disorders of fatty acid metabolism 12. Disorders of fatty acid metabolism: carnitine metabolism 13. Disorder of glycine metabolism 14. Disorder of glycine metabolism: Non ketotic hyperglycinaemia 15. Hyperammonaemia of the newborn 16. Disorders of lysine and hydroxylysine metabolism 17. Disorders of ornithine metabolism 18. Disorders of pyruvate metabolism and gluconeogenesis 19. Disorder of carbohydrate metabolism (unknown or unspecified cause) 20. Down Syndrome (Trisomy 21) 21. Trisomy 21 22. Edwards Syndrome (Trisomy 18) 23. Trisomy 18 24. Patau Syndrome (Trisomy 13) 25. Trisomy 13
Congenital infections	**Episodic variables:** Any of the following diagnosis codes entered into any *Diagnosis* field: 1. Congenital viral disease (specify) 2. Syphilis - latent congenital 3. Congenital rubella syndrome

Appendix 1: Definition of brain injuries occurring during or soon after birth using the National Neonatal Research Database (NNRD)

	4. Congenital cytomegalovirus infection 5. Congenital herpes [herpes simplex] infection 6. Other congenital viral diseases 7. Congenital viral disease (unknown or unspecified cause) 8. Congenital toxoplasmosis
Congenital brain abnormalities	**Episodic variables:** Any of the following diagnosis codes entered into any *Diagnosis* field: 1. Malformations of aqueduct of Sylvius 2. Atresia of foramina of Magendie and Luschka 3. Atresia of foramina of Magendie and Luschka 4. Other congenital hydrocephalus 5. X linked congenital hydrocephalus 6. Congenital hydrocephalus (unknown or unspecified cause) 7. Congenital hydrocephalus 8. Lissencephaly 9. Vermal agenesis 10. Septum pelucidum absence – congenital 11. Congenital malformations of corpus callosum 12. Arhinencephaly 13. Holoprosencephaly 14. Other reduction deformities of brain 15. Septo-optic dysplasia 16. Other specified congenital malformations of brain 17. Congenital malformation of brain (unknown or unspecified cause) 18. Other congenital malformations of brain 19. Cervical spina bifida with hydrocephalus 20. Thoracic spina bifida with hydrocephalus 21. Spina bifida (unknown or unspecified cause) 22. Spina bifida 23. Amyelia 24. Hypoplasia and dysplasia of spinal cord 25. Other specified congenital malformations of spinal cord 26. Congenital malformation of spinal cord (unknown or unspecified cause) 27. Nerve palsies – congenital 28. Arnold-Chiari syndrome 29. Other specified congenital malformations of nervous system 30. Congenital malformation of nervous system (unknown or unspecified cause) 31. Other congenital malformations of nervous system 32. Congenital Hydrocephalus

Appendix 2: Mapping hospital of birth to Neonatal ODN. Mapping provided by Department of Health and Social Care using a combination of data from the Royal College of Obstetricians and Gynaecologists (RCOG) organisational survey[28] and data from MBRRACE-UK[29] .

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Airedale General Hospital	AIREDALE NHS FOUNDATION TRUST	Yorkshire & Humber
Alnwick Infirmary	NORTHUMBRIA HEALTHCARE NHS FOUNDATION TRUST	Northern
Ashcombe Birth Centre, Weston General Hospital	WESTON AREA HEALTH NHS TRUST	South West
Aveta Birth Unit, Cheltenham General Hospital	GLOUCESTERSHIRE HOSPITALS NHS FOUNDATION TRUST	South West
Barkantine Birth Centre	BARTS HEALTH NHS TRUST	London (North Central & East London)
Barking Birth Centre	BARTS HEALTH NHS TRUST	London (North Central & East London)
Barnet Hospital	ROYAL FREE LONDON NHS FOUNDATION TRUST	London (North Central & East London)
Barnsley Hospital NHS Foundation Trust HQ	BARNSLEY HOSPITAL NHS FOUNDATION TRUST	Yorkshire & Humber
Basildon University Hospital	BASILDON AND THURROCK UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	East of England
Basingstoke and North Hampshire Hospital	HAMPSHIRE HOSPITALS NHS FOUNDATION TRUST	Thames Valley & Wessex
Bassetlaw Hospital	DONCASTER AND BASSETLAW HOSPITALS NHS FOUNDATION TRUST	Yorkshire & Humber
Bedford Hospital South Wing	BEDFORD HOSPITAL NHS TRUST	East of England
Berwick Infirmary	NORTHUMBRIA HEALTHCARE NHS FOUNDATION TRUST	Northern
Birmingham Women's Hospital	BIRMINGHAM WOMEN'S AND CHILDREN'S NHS FOUNDATION TRUST	Southern West Midlands
Blackburn Birth Centre	EAST LANCASHIRE HOSPITALS NHS TRUST	North West (Lancashire & South Cumbria)
Blackpool Victoria Hospital	BLACKPOOL TEACHING HOSPITALS NHS FOUNDATION TRUST	Lancashire & South Cumbria
Blake Maternity Centre, Gosport War Memorial Hospital	PORTSMOUTH HOSPITALS NHS TRUST	Thames Valley & Wessex
Bradford Royal Infirmary	BRADFORD TEACHING HOSPITALS NHS FOUNDATION TRUST	Yorkshire & Humber

[28] NMPA project team. National Maternity and Perinatal Audit: organisational report 2017. RCOG London, 2017. http://www.maternityaudit.org.uk/downloads/NMPA%20organisational%20report%202017.pdf accessed 3rd April 2019.
[29] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018. https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Perinatal%20Surveillance%20Full%20Report%20for%202016%20-%20June%202018.pdf accessed 12th February 2019

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Bridgnorth Hospital	SHREWSBURY AND TELFORD HOSPITAL NHS TRUST	Staffordshire, Shropshire, & Black County
Bridgwater Community Hospital	TAUNTON AND SOMERSET NHS FOUNDATION TRUST	South West
Bronte Birth Centre, Dewsbury and District Hospital	MID YORKSHIRE HOSPITALS NHS TRUST	Yorkshire & Humber
Broomfield Hospital	MID ESSEX HOSPITAL SERVICES NHS TRUST	East of England
Calderdale Royal Hospital	CALDERDALE AND HUDDERSFIELD NHS FOUNDATION TRUST	Yorkshire & Humber
Chelsea and Westminster Hospital	CHELSEA AND WESTMINSTER HOSPITAL NHS FOUNDATION TRUST	London (North West London)
Chesterfield Royal Hospital	CHESTERFIELD ROYAL HOSPITAL NHS FOUNDATION TRUST	Yorkshire & Humber
Chippenham Community Hospital	ROYAL UNITED HOSPITALS BATH NHS FOUNDATION TRUST	South West
Chorley and South Ribble Hospital	LANCASHIRE TEACHING HOSPITALS NHS FOUNDATION TRUST	North West (Lancashire & South Cumbria)
City Campus	NOTTINGHAM UNIVERSITY HOSPITALS NHS TRUST	Trent Perinatal & Central Neonatal (Trent)
City Hospital	SANDWELL AND WEST BIRMINGHAM HOSPITALS NHS TRUST	Southern West Midlands
Clacton and District Hospital	COLCHESTER HOSPITAL UNIVERSITY NHS FOUNDATION TRUST	East of England
Colchester General Hospital	COLCHESTER HOSPITAL UNIVERSITY NHS FOUNDATION TRUST	East of England
Conquest Hospital	EAST SUSSEX HEALTHCARE NHS TRUST	South East Coast
Cossham Hospital	NORTH BRISTOL NHS TRUST	South West
Cotswold Birth Centre, Chipping Norton Community Hospital	OXFORD UNIVERSITY HOSPITALS NHS TRUST	Thames Valley & Wessex
Countess Of Chester Hospital	COUNTESS OF CHESTER HOSPITAL NHS FOUNDATION TRUST	North West (Cheshire & Merseyside)
County Hospital	UNIVERSITY HOSPITALS OF NORTH MIDLANDS NHS TRUST	Staffordshire, Shropshire, & Black County
Crowborough Birthing Centre	MAIDSTONE AND TUNBRIDGE WELLS NHS TRUST	South East Coast
Crowborough Birthing Centre	EAST SUSSEX HEALTHCARE NHS TRUST	South East Coast
Cumberland Infirmary	NORTH CUMBRIA UNIVERSITY HOSPITALS NHS TRUST	Northern
Darent Valley Hospital	DARTFORD AND GRAVESHAM NHS TRUST	South East Coast
Darlington Memorial Hospital	COUNTY DURHAM AND DARLINGTON NHS FOUNDATION TRUST	Northern
Derriford Hospital	PLYMOUTH HOSPITALS NHS TRUST	South West
Diana, Princess Of Wales Hospital	NORTHERN LINCOLNSHIRE AND GOOLE NHS FOUNDATION TRUST	Yorkshire & Humber

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Doncaster Royal Infirmary	DONCASTER AND BASSETLAW HOSPITALS NHS FOUNDATION TRUST	Yorkshire & Humber
Dorset County Hospital	DORSET COUNTY HOSPITAL NHS FOUNDATION TRUST	Thames Valley & Wessex
Duchess of Kent Maternity Unit, Hillingdon Hospital	THE HILLINGDON HOSPITALS NHS FOUNDATION TRUST	London (North West London)
East Surrey Hospital	SURREY AND SUSSEX HEALTHCARE NHS TRUST	South East Coast
Eastbourne District General Hospital	EAST SUSSEX HEALTHCARE NHS TRUST	South East Coast
Edgware Birth Centre	ROYAL FREE LONDON NHS FOUNDATION TRUST	London (North Central & East London)
Epsom Hospital	EPSOM AND ST HELIER UNIVERSITY HOSPITALS NHS TRUST	London (South London)
Friarage Hospital Site	SOUTH TEES HOSPITALS NHS FOUNDATION TRUST	Northern
Friarwood Birth Centre, Pontefract General Infirmary	MID YORKSHIRE HOSPITALS NHS TRUST	Yorkshire & Humber
Frimley Park Hospital	FRIMLEY HEALTH NHS FOUNDATION TRUST	South East Coast
Frome Community Hospital	ROYAL UNITED HOSPITALS BATH NHS FOUNDATION TRUST	South West
Furness General Hospital	UNIVERSITY HOSPITALS OF MORECAMBE BAY NHS FOUNDATION TRUST	North West (Lancashire & South Cumbria)
George Eliot Hospital - Acute Services	GEORGE ELIOT HOSPITAL NHS TRUST	Trent Perinatal & Central Neonatal (Central)
Gloucestershire Royal Hospital	GLOUCESTERSHIRE HOSPITALS NHS FOUNDATION TRUST	South West
Good Hope Hospital	HEART OF ENGLAND NHS FOUNDATION TRUST	Southern West Midlands
Goole and District Hospital (Acute)	NORTHERN LINCOLNSHIRE AND GOOLE NHS FOUNDATION TRUST	Yorkshire & Humber
Grange Maternity Centre, Petersfield Community Hospital	PORTSMOUTH HOSPITALS NHS TRUST	Thames Valley & Wessex
Halcyon Birth Centre	SANDWELL AND WEST BIRMINGHAM HOSPITALS NHS TRUST	Southern West Midlands
Hampshire Hospitals Maternity Centre, Andover War Memorial Hospital	HAMPSHIRE HOSPITALS NHS FOUNDATION TRUST	Thames Valley & Wessex
Harrogate District Hospital	HARROGATE AND DISTRICT NHS FOUNDATION TRUST	Yorkshire & Humber
Harwich Maternity	COLCHESTER HOSPITAL UNIVERSITY NHS FOUNDATION TRUST	East of England
Heartlands Hospital	HEART OF ENGLAND NHS FOUNDATION TRUST	Southern West Midlands
Helme Chase Midwife-led Unit, Westmorland General Hospital	UNIVERSITY HOSPITALS OF MORECAMBE BAY NHS FOUNDATION TRUST	North West (Lancashire & South Cumbria)
Helston Birth Centre	ROYAL CORNWALL HOSPITALS NHS TRUST	South West
Hereford County Hospital	WYE VALLEY NHS TRUST	Southern West Midlands

Chelsea and Westminster Hospital NHS
NHS Foundation Trust

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Hexham General Hospital	NORTHUMBRIA HEALTHCARE NHS FOUNDATION TRUST	Northern
Hinchingbrooke Hospital	HINCHINGBROOKE HEALTH CARE NHS TRUST	East of England
Homerton University Hospital	HOMERTON UNIVERSITY HOSPITAL NHS FOUNDATION TRUST	London (North Central & East London)
Honiton Hospital	ROYAL DEVON AND EXETER NHS FOUNDATION TRUST	South West
Horton General Hospital	OXFORD UNIVERSITY HOSPITALS NHS TRUST	Thames Valley & Wessex
Huddersfield Royal Infirmary	CALDERDALE AND HUDDERSFIELD NHS FOUNDATION TRUST	Yorkshire & Humber
Hull Royal Infirmary	HULL AND EAST YORKSHIRE HOSPITALS NHS TRUST	Yorkshire & Humber
James Paget University Hospital	JAMES PAGET UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	East of England
Jessop Wing, Royal Hallamshire Hospital	SHEFFIELD TEACHING HOSPITALS NHS FOUNDATION TRUST	Yorkshire & Humber
John Radcliffe Hospital	OXFORD UNIVERSITY HOSPITALS NHS TRUST	Thames Valley & Wessex
Kettering General Hospital	KETTERING GENERAL HOSPITAL NHS FOUNDATION TRUST	Trent Perinatal & Central Neonatal (Central)
King's College Hospital (Denmark Hill)	KING'S COLLEGE HOSPITAL NHS FOUNDATION TRUST	London (South London)
Kingston Hospital	KINGSTON HOSPITAL NHS FOUNDATION TRUST	London (South London)
Lancashire Womens and Newborn Centre, Burnley General teaching	EAST LANCASHIRE HOSPITALS NHS TRUST	North West (Lancashire & South Cumbria)
Leeds General Infirmary	LEEDS TEACHING HOSPITALS NHS TRUST	Yorkshire & Humber
Leicester General Hospital	UNIVERSITY HOSPITALS OF LEICESTER NHS TRUST	Trent Perinatal & Central Neonatal (Central)
Leicester Royal Infirmary	UNIVERSITY HOSPITALS OF LEICESTER NHS TRUST	Trent Perinatal & Central Neonatal (Central)
Leighton Hospital	MID CHESHIRE HOSPITALS NHS FOUNDATION TRUST	North West (Cheshire & Merseyside)
Lincoln County Hospital	UNITED LINCOLNSHIRE HOSPITALS NHS TRUST	Trent Perinatal & Central Neonatal (Trent)
Lister Hospital	EAST AND NORTH HERTFORDSHIRE NHS TRUST	East of England
Liverpool Womens Hospital	LIVERPOOL WOMEN'S NHS FOUNDATION TRUST	North West (Cheshire & Merseyside)
Ludlow Hospital	SHREWSBURY AND TELFORD HOSPITAL NHS TRUST	Staffordshire, Shropshire, & Black County
Luton and Dunstable Hospital	LUTON AND DUNSTABLE UNIVERSITY HOSPITAL NHS FOUNDATION TRUST	East of England
Macclesfield District General Hospital	EAST CHESHIRE NHS TRUST	North West (Cheshire & Merseyside)
Maidstone District General Hospital	MAIDSTONE AND TUNBRIDGE WELLS NHS TRUST	South East Coast
Manor Hospital	WALSALL HEALTHCARE NHS TRUST	Staffordshire, Shropshire, & Black County
Mayday (Croydon) University Hospital	CROYDON HEALTH SERVICES NHS TRUST	London (South London)
Medway Maritime Hospital	MEDWAY NHS FOUNDATION TRUST	South East Coast

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Milton Keynes Hospital	MILTON KEYNES HOSPITAL NHS FOUNDATION TRUST	Thames Valley & Wessex
Musgrove Park Hospital	TAUNTON AND SOMERSET NHS FOUNDATION TRUST	South West
New Cross Hospital	THE ROYAL WOLVERHAMPTON NHS TRUST	Staffordshire, Shropshire, & Black County
New Forest Birth Centre	UNIVERSITY HOSPITAL SOUTHAMPTON NHS FOUNDATION TRUST	Thames Valley & Wessex
Newham General Hospital	BARTS HEALTH NHS TRUST	London (North Central & East London)
Norfolk and Norwich University Hospital	NORFOLK AND NORWICH UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	East of England
North Devon District Hospital	NORTHERN DEVON HEALTHCARE NHS TRUST	South West
North Manchester General Hospital	PENNINE ACUTE HOSPITALS NHS TRUST	North West (Greater Manchester)
North Middlesex Hospital	NORTH MIDDLESEX UNIVERSITY HOSPITAL NHS TRUST	London (North Central & East London)
Northampton General Hospital (Acute)	NORTHAMPTON GENERAL HOSPITAL NHS TRUST	Trent Perinatal & Central Neonatal (Central)
Northwick Park Hospital	LONDON NORTH WEST HEALTHCARE NHS TRUST	London (North West London)
Okehampton Community Hospital	ROYAL DEVON AND EXETER NHS FOUNDATION TRUST	South West
Ormskirk and District General Hospital	SOUTHPORT AND ORMSKIRK HOSPITAL NHS TRUST	North West (Cheshire & Merseyside)
Oswestry Maternity Unit	SHREWSBURY AND TELFORD HOSPITAL NHS TRUST	Staffordshire, Shropshire, & Black County
Paulton Memorial Hospital	ROYAL UNITED HOSPITALS BATH NHS FOUNDATION TRUST	South West
Penrith Hospital	NORTH CUMBRIA UNIVERSITY HOSPITALS NHS TRUST	Northern
Peterborough City Hospital	PETERBOROUGH AND STAMFORD HOSPITALS NHS FOUNDATION TRUST	East of England
Pilgrim Hospital	UNITED LINCOLNSHIRE HOSPITALS NHS TRUST	Trent Perinatal & Central Neonatal (Trent)
Pinderfields General Hospital	MID YORKSHIRE HOSPITALS NHS TRUST	Yorkshire & Humber
Poole General Hospital	POOLE HOSPITAL NHS FOUNDATION TRUST	Thames Valley & Wessex
Portsmouth Maternity Centre, St Mary's Hospital	PORTSMOUTH HOSPITALS NHS TRUST	Thames Valley & Wessex
Princess Alexandra Hospital	THE PRINCESS ALEXANDRA HOSPITAL NHS TRUST	East of England
Princess Anne Hospital	UNIVERSITY HOSPITAL SOUTHAMPTON NHS FOUNDATION TRUST	Thames Valley & Wessex
Princess Anne Wing RUH	ROYAL UNITED HOSPITALS BATH NHS FOUNDATION TRUST	South West
Princess Royal Hospital	BRIGHTON AND SUSSEX UNIVERSITY HOSPITALS NHS TRUST	South East Coast
Princess Royal University Hospital	KING'S COLLEGE HOSPITAL NHS FOUNDATION TRUST	London (South London)
Queen Alexandra Hospital	PORTSMOUTH HOSPITALS NHS TRUST	Thames Valley & Wessex
Queen Charlotte's Hospital	IMPERIAL COLLEGE HEALTHCARE NHS TRUST	London (North West London)
Queen Elizabeth Hospital	LEWISHAM AND GREENWICH NHS TRUST	London (South London)

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Queen Elizabeth Hospital	GATESHEAD HEALTH NHS FOUNDATION TRUST	Northern
Queen Elizabeth The Queen Mother Hospital	EAST KENT HOSPITALS UNIVERSITY NHS FOUNDATION TRUST	South East Coast
Queen's Hospital	BARKING, HAVERING AND REDBRIDGE UNIVERSITY HOSPITALS NHS TRUST	London (North Central & East London)
Queen's Hospital, Burton Upon Trent	BURTON HOSPITALS NHS FOUNDATION TRUST	Trent Perinatal & Central Neonatal (Central)
Queen's Medical Centre Campus	NOTTINGHAM UNIVERSITY HOSPITALS NHS TRUST	Trent Perinatal & Central Neonatal (Trent)
Rosie Hospital	CAMBRIDGE UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	East of England
Rossendale Birth Centre	EAST LANCASHIRE HOSPITALS NHS TRUST	North West (Lancashire & South Cumbria)
Rotherham District General Hospital	THE ROTHERHAM NHS FOUNDATION TRUST	Yorkshire & Humber
Royal Albert Edward Infirmary	WRIGHTINGTON, WIGAN AND LEIGH NHS FOUNDATION TRUST	North West (Greater Manchester)
Royal Berkshire Hospital	ROYAL BERKSHIRE NHS FOUNDATION TRUST	Thames Valley & Wessex
Royal Bolton Hospital	BOLTON NHS FOUNDATION TRUST	North West (Greater Manchester)
Royal Bournemouth General Hospital	THE ROYAL BOURNEMOUTH AND CHRISTCHURCH HOSPITALS NHS FOUNDATION TRUST	Thames Valley & Wessex
Royal Cornwall Hospital (Treliske)	ROYAL CORNWALL HOSPITALS NHS TRUST	South West
Royal Derby Hospital	DERBY TEACHING HOSPITALS NHS FOUNDATION TRUST	Trent Perinatal & Central Neonatal (Trent)
Royal Devon and Exeter Hospital (Wonford)	ROYAL DEVON AND EXETER NHS FOUNDATION TRUST	South West
Royal Free Hospital	ROYAL FREE LONDON NHS FOUNDATION TRUST	London (North Central & East London)
Royal Hampshire County Hospital	HAMPSHIRE HOSPITALS NHS FOUNDATION TRUST	Thames Valley & Wessex
Royal Lancaster Infirmary	UNIVERSITY HOSPITALS OF MORECAMBE BAY NHS FOUNDATION TRUST	North West (Lancashire & South Cumbria)
Royal Oldham Hospital	PENNINE ACUTE HOSPITALS NHS TRUST	North West (Greater Manchester)
Royal Preston Hospital	LANCASHIRE TEACHING HOSPITALS NHS FOUNDATION TRUST	North West (Lancashire & South Cumbria)
Royal Shrewsbury Hospital	SHREWSBURY AND TELFORD HOSPITAL NHS TRUST	Staffordshire, Shropshire, & Black County
Royal Stoke University Hospital	UNIVERSITY HOSPITALS OF NORTH MIDLANDS NHS TRUST	Staffordshire, Shropshire, & Black County
Royal Surrey County Hospital	ROYAL SURREY COUNTY HOSPITAL NHS FOUNDATION TRUST	South East Coast
Royal Sussex County Hospital	BRIGHTON AND SUSSEX UNIVERSITY HOSPITALS NHS TRUST	South East Coast
Russells Hall Hospital	THE DUDLEY GROUP NHS FOUNDATION TRUST	Staffordshire, Shropshire, & Black County
Salisbury District Hospital	SALISBURY NHS FOUNDATION TRUST	Thames Valley & Wessex
Samuel Johnson Birth Centre Litchfield	BURTON HOSPITALS NHS FOUNDATION TRUST	Trent Perinatal & Central Neonatal (Central)
Scarborough General Hospital	YORK TEACHING HOSPITAL NHS FOUNDATION TRUST	Yorkshire & Humber

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
Scunthorpe General Hospital	NORTHERN LINCOLNSHIRE AND GOOLE NHS FOUNDATION TRUST	Yorkshire & Humber
Sherwood Birthing Unit, King's Mill Hospital	SHERWOOD FOREST HOSPITALS NHS FOUNDATION TRUST	Trent Perinatal & Central Neonatal (Trent)
Solihull Hospital	HEART OF ENGLAND NHS FOUNDATION TRUST	Southern West Midlands
South Tyneside District Hospital	SOUTH TYNESIDE NHS FOUNDATION TRUST	Northern
Southend Hospital	SOUTHEND UNIVERSITY HOSPITAL NHS FOUNDATION TRUST	East of England
Southmead Hospital	NORTH BRISTOL NHS TRUST	South West
St Austell Hospital - Penrice Birthing Unit	ROYAL CORNWALL HOSPITALS NHS TRUST	South West
St George's Hospital (Tooting)	ST GEORGE'S UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	London (South London)
St Helier Hospital	EPSOM AND ST HELIER UNIVERSITY HOSPITALS NHS TRUST	London (South London)
St James's University Hospital	LEEDS TEACHING HOSPITALS NHS TRUST	Yorkshire & Humber
St Mary's Birth Centre	ROYAL CORNWALL HOSPITALS NHS TRUST	South West
St Mary's Hospital	UNIVERSITY HOSPITALS OF LEICESTER NHS TRUST	Trent Perinatal & Central Neonatal (Central)
St Mary's Hospital	CENTRAL MANCHESTER UNIVERSITY HOSPITALS NHS FOUNDATION TRUST	North West (Greater Manchester)
St Mary's Hospital	ISLE OF WIGHT NHS TRUST	Thames Valley & Wessex
St Mary's Hospital (HQ)	IMPERIAL COLLEGE HEALTHCARE NHS TRUST	London (North West London)
St Michael's Hospital	UNIVERSITY HOSPITALS BRISTOL NHS FOUNDATION TRUST	South West
St Michael's Hospital, Braintree	MID ESSEX HOSPITAL SERVICES NHS TRUST	East of England
St Peter's Hospital	ASHFORD AND ST PETER'S HOSPITALS NHS FOUNDATION TRUST	South East Coast
St Peter's Hospital, Maldon	MID ESSEX HOSPITAL SERVICES NHS TRUST	East of England
St Richard's Hospital	WESTERN SUSSEX HOSPITALS NHS FOUNDATION TRUST	South East Coast
St Thomas' Hospital	GUY'S AND ST THOMAS' NHS FOUNDATION TRUST	London (South London)
Stepping Hill Hospital	STOCKPORT NHS FOUNDATION TRUST	North West (Greater Manchester)
Stoke Mandeville Hospital	BUCKINGHAMSHIRE HEALTHCARE NHS TRUST	Thames Valley & Wessex
Stroud Maternity Unit	GLOUCESTERSHIRE HOSPITALS NHS FOUNDATION TRUST	South West
Sunderland Royal Hospital	CITY HOSPITALS SUNDERLAND NHS FOUNDATION TRUST	Northern
Tameside General Hospital	TAMESIDE HOSPITAL NHS FOUNDATION TRUST	North West (Greater Manchester)
The Great Western Hospital	GREAT WESTERN HOSPITALS NHS FOUNDATION TRUST	South West
The Ipswich Hospital NHS Trust	IPSWICH HOSPITAL NHS TRUST	East of England
The James Cook University Hospital	SOUTH TEES HOSPITALS NHS FOUNDATION TRUST	Northern

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
The Northumbria	NORTHUMBRIA HEALTHCARE NHS FOUNDATION TRUST	Northern
The Princess Royal Hospital	SHREWSBURY AND TELFORD HOSPITAL NHS TRUST	Staffordshire, Shropshire, & Black County
The Queen Elizabeth Hospital	THE QUEEN ELIZABETH HOSPITAL, KING'S LYNN, NHS FOUNDATION TRUST	East of England
The Royal London Hospital	BARTS HEALTH NHS TRUST	London (North Central & East London)
The Royal Victoria Infirmary	THE NEWCASTLE UPON TYNE HOSPITALS NHS FOUNDATION TRUST	Northern
The Tunbridge Wells Hospital	MAIDSTONE AND TUNBRIDGE WELLS NHS TRUST	South East Coast
The Whittington Hospital	THE WHITTINGTON HOSPITAL NHS TRUST	London (North Central & East London)
Tiverton and District Hospital	ROYAL DEVON AND EXETER NHS FOUNDATION TRUST	South West
Torbay Hospital	TORBAY AND SOUTH DEVON NHS FOUNDATION TRUST	South West
Trowbridge Community Hospital	ROYAL UNITED HOSPITALS BATH NHS FOUNDATION TRUST	South West
University College Hospital Elizabeth Garrett Anderson Wing	UNIVERSITY COLLEGE LONDON HOSPITALS NHS FOUNDATION TRUST	London (North Central & East London)
University Hospital (Coventry)	UNIVERSITY HOSPITALS COVENTRY AND WARWICKSHIRE NHS TRUST	Trent Perinatal & Central Neonatal (Central)
University Hospital Lewisham	LEWISHAM AND GREENWICH NHS TRUST	London (South London)
University Hospital Of Hartlepool	NORTH TEES AND HARTLEPOOL NHS FOUNDATION TRUST	Northern
University Hospital Of North Durham	COUNTY DURHAM AND DARLINGTON NHS FOUNDATION TRUST	Northern
University Hospital Of North Tees	NORTH TEES AND HARTLEPOOL NHS FOUNDATION TRUST	Northern
Wallingford Community Hospital	OXFORD UNIVERSITY HOSPITALS NHS TRUST	Thames Valley & Wessex
Walsall Midwifery Led Unit	WALSALL HEALTHCARE NHS TRUST	Staffordshire, Shropshire, & Black County
Wantage Hospital Maternity Unit	OXFORD UNIVERSITY HOSPITALS NHS TRUST	Thames Valley & Wessex
Warrington Hospital	WARRINGTON AND HALTON HOSPITALS NHS FOUNDATION TRUST	North West (Cheshire & Merseyside)
Warwick Hospital	SOUTH WARWICKSHIRE NHS FOUNDATION TRUST	East Midlands (Central)
Watford General Hospital	WEST HERTFORDSHIRE HOSPITALS NHS TRUST	East of England
West Cumberland Hospital	NORTH CUMBRIA UNIVERSITY HOSPITALS NHS TRUST	Northern
West Middlesex University Hospital	CHELSEA AND WESTMINSTER HOSPITAL NHS FOUNDATION TRUST	London (North West London)
West Suffolk Hospital	WEST SUFFOLK NHS FOUNDATION TRUST	East of England
Wexham Park Hospital	FRIMLEY HEALTH NHS FOUNDATION TRUST	South East Coast
Whipps Cross University Hospital	BARTS HEALTH NHS TRUST	London (North Central & East London)
Whiston Hospital	ST HELENS AND KNOWSLEY HOSPITALS NHS TRUST	North West (Cheshire & Merseyside)
Whitelake Unit, Newton Abbot Community Hospital	TORBAY AND SOUTH DEVON NHS FOUNDATION TRUST	South West

Appendix 2: Mapping hospital of birth to Neonatal ODN

Maternity Unit Name	Trust Name	Neonatal ODN Associated with Trust
William Harvey Hospital (Ashford)	EAST KENT HOSPITALS UNIVERSITY NHS FOUNDATION TRUST	South East Coast
Wirral Women and Children's Hospital, Arrowe Park Hospital	WIRRAL UNIVERSITY TEACHING HOSPITAL NHS FOUNDATION TRUST	North West (Cheshire & Merseyside)
Worcestershire Royal Hospital	WORCESTERSHIRE ACUTE HOSPITALS NHS TRUST	Southern West Midlands
Worthing Hospital	WESTERN SUSSEX HOSPITALS NHS FOUNDATION TRUST	South East Coast
Wycombe Hospital	BUCKINGHAMSHIRE HEALTHCARE NHS TRUST	Thames Valley & Wessex
Wythenshawe Hospital	UNIVERSITY HOSPITAL OF SOUTH MANCHESTER NHS FOUNDATION TRUST	North West (Greater Manchester)
Yeovil District Hospital	YEOVIL DISTRICT HOSPITAL NHS FOUNDATION TRUST	South West
York Hospital	YORK TEACHING HOSPITAL NHS FOUNDATION TRUST	Yorkshire & Humber